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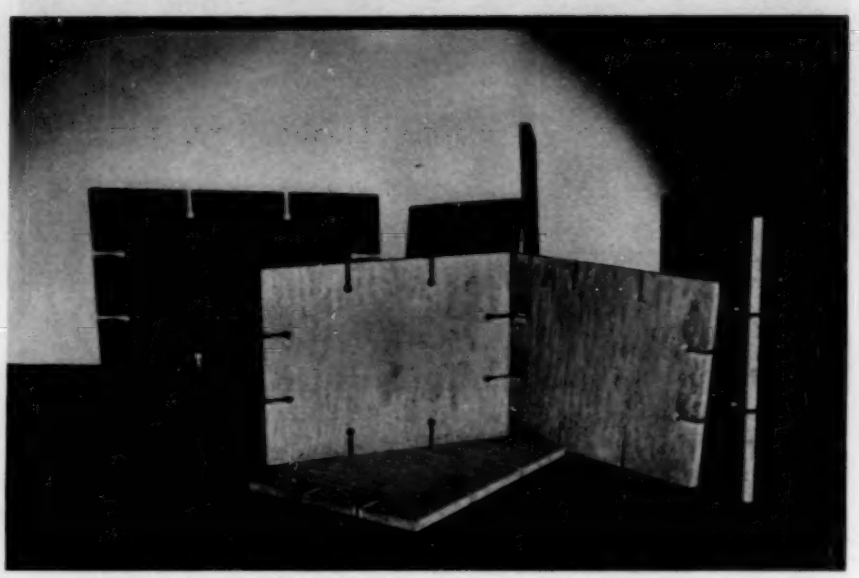

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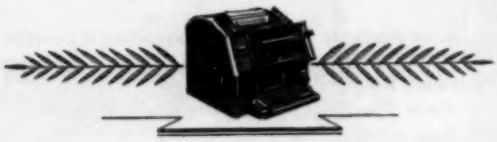

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ACID-RESISTING, DRY-PROCESS, CAST-IRON ENAMELS, AND THE EFFECTS OF BaO, PbO, AND ZnO[1]

By L. D. Fetterolf

ABSTRACT

An enamel composition to which any workable enamel of this type must quite closely conform is given. Eighty-six per cent of the enamel composition must be held within definite proportions. The function of each of these constituents and the percentage required are discussed. The remaining 14% of the enamel may be supplied by combinations of BaO, PbO, and ZnO, with some latitude in proportions permissible. Results of a careful study of the influence of each on smelting properties, acid resistance, fusibility, covering power, color, and brightness are presented.

I. Introduction

Little difficulty is experienced in compounding enamel glasses which for all practical purposes are acid resistant. Along with the development of acid-resistant compositions, there arise, however, other problems, chief of which are those of workability, color, and opacity. Workability is necessarily sacrificed at the expense of acid resistance and is probably the important factor in acid-resisting enamels for cast iron. This paper gives results of attempts to develop an acid-resisting enamel and of attempts to evaluate the contributions of the oxides of barium, lead, and zinc to important properties of enamels of this type.

(1) Literature The literature prior to 1930 contained information relative to acid-resisting enamels, methods of testing, etc., but conclusions drawn were so divergent that it is doubtful whether the information given served as a reliable guide for anyone wishing to develop acid-resisting compositions. During the past year, there appeared a paper by Andrews[2] which covered the results of a comprehensive investigation of the problem and which presented a valuable store of information. The work with which the present paper treats was largely done before the appearance of Andrew's publication and insofar as there is agreement the results to be presented may be considered confirmatory of his conclusions.

II. Outline of Investigation

The procedure in the development of satisfactory compositions was that of starting with very refractory, acid-resisting enamels and making subsequent modifications to increase fusibility and improve other properties without reducing acid resistance under the limit arbitrarily set.

Preparation and study of a large number of enamels led to the selection

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Enamel Division). Received March 14, 1931.

[2] *Jour. Amer. Ceram. Soc.*, **13** [8], 509 (1930).

of a composition to which, it is believed, workable enamels must quite closely conform. It appeared to be essential that 86% (exclusive of BaO, PbO, and ZnO) of the melted weight of the enamel be made up of constituents falling within quite narrow limits. The remaining 14% might be furnished by Ba, Pb, and Zn oxides in various combinations without an adverse effect on acid resistance. Each appeared to contribute desirable properties.

A series of enamels was accordingly made up in which 86% of each enamel was held constant; the remainder was supplied by Ba, Pb, and Zn oxides in combinations represented by points on a triaxial field as indicated in Fig. 1. Various tests were performed in order to determine the relative merits of the variables.

III. Experimental Methods

(1) Preparation Crucible smelts of 4-pound batches were made and the enamels prepared in a manner representative of laboratory practice.

(2) Application Inasmuch as it was desired to make color and brightness measurements on enamels, it was found to be expedient to apply enamels in coats of equal thickness. This was accomplished by an arrangement whereby the enamel was weighed as it was applied upon the test plate.

(3) Acid Tests A number of acid tests was used. For the sake of comparison of results with those of other investigators, the spot test made by using a 7% citric acid solution was employed. This was supplemented by a test with 7% HCl which is much more severe in its action than citric acid. In both tests, the acid was allowed to remain on a small portion of enamel surface for fifteen minutes. In addition to the tests enumerated, enamels of the triaxial field were tested by exposure to 20% HCl for twenty-four hours.

(4) Fusibility Comparison of fusibilities was made by observing the amount of time required for enamels to level when fired under uniform conditions.

A comparison was also obtained by cone deformation tests made in the manner prescribed by the Enamel Division Standards Committee. The starting point of deformation is quite indefinite. To more sharply define this point, a nichrome wire was stretched across the furnace chamber behind and just below the tips of the cones and the starting temperature taken as the temperature at which the tip of the cone came in the line of sight with the wire. At best, the starting temperature appears to be difficult to check. For this reason, it is believed that little meaning can be attached to cone deformation ranges. Cone deformation points were more sharply defined and good checks were obtained on duplicate tests.

(5) Color and Opacity Color of enamels was judged visually and also determined by using the Pfund colorimeter which measures the percentage of any chosen wave-length of light that is diffusely reflected. Spectral reflection values for blue, green, yellow, and red light were obtained on equal weights of enamel applied on flat plates measuring $4^1/_2$ by $4^1/_2$ inches. Strictly speaking, opacity itself was not measured by this method inasmuch as enamels were applied sufficiently thick that the iron and undercoat background were completely obliterated. Averages of the four spectral reflection values gave, however, another interesting and important property, namely, that of brightness, a value determined by the total amount of light diffusely reflected as compared with the incident light.

(6) Development of Basic Composition Study of a large number of enamel formulas led to the adoption of the following basic composition:

	(%)		(%)
Na_2O	18	SiO_2	42
B_2O_3	5	Sb_2O_3	10
CaO	4	BaO }	
CaF_2	1	PbO }	14
TiO_2	6	ZnO }	

Observations to be made are true with respect to enamels in which the variable portion was furnished by BaO, PbO, and ZnO in a number of different combinations. References to acid resistance imply the spot test with 7% HCl.

IV. Results

(1) Refractory Oxides It appears to be necessary to maintain the refractory oxides, SiO_2 and TiO_2, at 48%. Increase in this percentage increases refractoriness while a decrease impairs acid resistance. TiO_2 in moderate amount apparently makes a slightly greater contribution to acid resistance than does a like amount of SiO_2 and markedly increases fusibility. Replacement of the 6% of TiO_2 by SiO_2 in a number of enamels containing various BaO-PbO-ZnO combinations increased cone deformation temperatures 18 to 25°F. Use of more than 6% TiO_2 aggravates the tendency to produce a yellow color, more especially when the PbO content is high.

(2) Opacifier Antimony oxide is the only satisfactory opacifier, other opacifying oxides being readily soluble in this type of enamel. The compound is preferably introduced in the form of sodium antimonate.

(3) Calcium Compounds CaO and CaF_2 have very pronounced effects on enamels of the basic composition given and 1% CaF_2 is an essential constituent. Four per cent of CaO and 1%

CaF_2 appear to be desirable as was made apparent by numerous total and partial replacements for the two.

Enamels containing 5% CaO-0% CaF_2 or 0%CaO-1%CaF_2 froth severely in smelting, have poor opacity, poor brightness, and inferior gloss.

Two per cent of lime with 1% CaF_2 are not sufficient to furnish the maximum benefit to be derived from lime. Even the small amount of CaF_2 has a tendency to reduce acid resistance, but for reasons given it seemingly cannot be eliminated.

Two per cent of CaF_2 greatly improves the color of high lead compositions but such an enamel fails to pass the acid test.

The action of other fluorine compounds parallels that of CaF_2 and a direct substitution may be made without resulting in any measurable change in enamel properties.

(4) Soda and Boric Oxide A proper balance with the constituents discussed is furnished by 18% Na_2O and 5% B_2O_3. Various combinations of Na_2O and B_2O_3 were tried and the proportions given furnish the most fusible enamel of satisfactory acid resistance. Acid resistance and gloss are increased by replacement of Na_2O with B_2O_3 but fusibility is greatly decreased, as was shown by an increase in cone deformation temperature of 7 to 8°F, corresponding to a 1% replacement of Na_2O by B_2O_3. This difference for cone deformation temperatures held for the composition interval between 22% Na_2O-1% B_2O_3 and 14% Na_2O-9% B_2O_3.

(5) Alumina Alumina has been omitted from the basic composition inasmuch as replacement of SiO_2 by small percentages of Al_2O_3 appeared to reduce acid resistance slightly and to decrease enamel workability as judged by leveling properties during firing.

(6) Effects of Variations in BaO, PbO, and ZnO As has been stated, considerable variation in the variable portion comprising a total of 14% BaO, PbO, and ZnO was found to be permissible insofar as acid resistance was concerned. Any readjustment in the constant portion, such as decrease of combined SiO_2 and TiO_2, increase of Na_2O, elimination of CaF_2, and numerous other changes, resulted in acid solubility or sacrifice of other desirable properties. These facts appear to furnish sufficient justification for an evaluation of the effects of BaO, PbO, and ZnO by systematic variations in their proportions when used to provide the variable content of the basic composition. The effects of the variables have been found to be qualitatively the same for other acid-resisting compositions. The results, therefore, apply specifically to the basic composition under study and probably generally to compositions of similar type.

(a) Smelting Compositions high in BaO showed poor smelting properties, the enamels bubbling and frothing to such an extent that crucible smelting was difficult. Four per cent BaO, added as

$BaCO_3$, was sufficient to produce this tendency and 6% aggravated it greatly.

High PbO, high ZnO, and intermediate compositions smelted excellently. The proportions of CaO and CaF_2 already referred to were necessary, however to insure satisfactory smelting of these compositions. The only difference noticeable between high PbO and high ZnO compositions was the greater fluidity of the former.

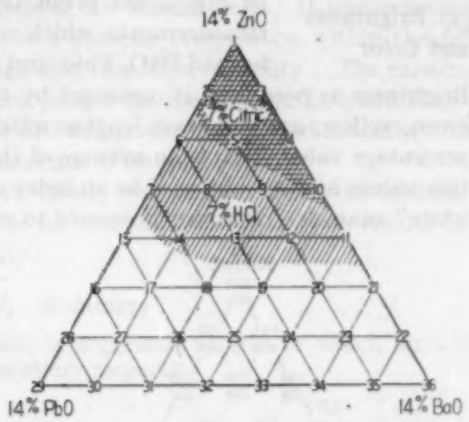

FIG. 1.—Results of acid tests. Shaded areas indicate loss of gloss or stain.

(b) Acid Resistance In Fig. 1 are indicated portions of the field in which compositions are attacked in the spot test made with 7% citric acid and 7% HCl. The few enamels indicated as being attacked by citric acid show barely perceptible traces of acid action. Gloss remains completely unaffected and a slight stain is visible only when viewed at a certain angle.

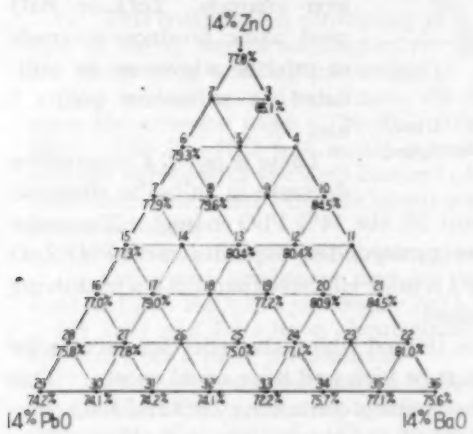

FIG. 2.—Results of reflection measurements. Results are averages of blue, green, yellow, and red reflection factors.

The action of 7% HCl is more severe and the extent of the so-called "attacked" area is much enlarged. Only a few compositions in the high ZnO region show any diminution of gloss. The remaining compositions of the area show only slight stains which gradually disappear as PbO or BaO, or both, replace ZnO.

A still more severe test was employed: that of immersing a portion of an enameled plate in 20% HCl for twenty-four hours. In this test, enamels 1–10 showed faint or marked loss of gloss depending upon the ZnO content. Points directly below this area showed slight staining. The line of demarcation for this test probably extends somewhat below the line for 7% HCl.

Results of these tests indicate that PbO and BaO are superior to ZnO in imparting acid resistance and that PbO may be slightly more effective than BaO.

(c) Brightness and Color

In Fig. 2 are given the results of spectral reflection measurements which afford a comparison of the effects of BaO, PbO, and ZnO with respect to brightness. Brightness as here used is measured by the proportions of incident blue, green, yellow, and red wave-lengths which are diffusely reflected. Each percentage value given is an average of the four individual spectral reflection values and may be used as an index of whiteness in comparing "near white" enamels. It is not necessary to rely on optical measurements for the distinctions, as differences of 1% are readily observed by usual inspection.

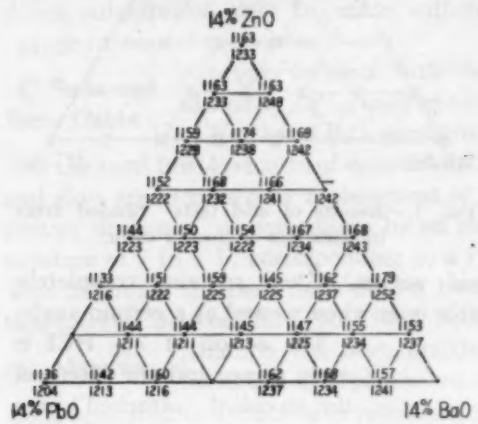

FIG. 3.—Results of cone fusion tests. Upper figure, starting temperature in °F; lower figure, deformation temperature.

Referring to Fig. 2, the high reflection factors for enamels, 3, 4, 10, 11, and 21 indicate the high reflection efficiencies of ZnO and BaO combinations. These enamels possess remarkable whiteness, much superior to ordinary commercial cast-iron enamels. ZnO or BaO used alone produces enamels of inferior whiteness as indicated by values for points 1 and 36.

There is noted a progressive decrease in values as compositions within the field approach point 29, the 14% PbO enamel. The order of arrangement of reflection factors corresponding to points on the PbO-ZnO and PbO-BaO sides shows that ZnO is more effective than BaO in improving the brightness of the high lead enamel.

In order that an enamel may be termed white, the reflection factors for different parts of the spectrum must be high and have equal values. This latter requirement is nearly met by enamels containing ZnO and BaO combinations and they may be classified as white. The reflection values for the high lead enamels are much lower and were the spectral reflection values for different parts of the spectrum of equal value, the enamels would be comparatively gray. Such enamels show, however, selectivity of color, there being a predominance of yellow and green reflection which becomes increasingly pronounced with increase in PbO content. The color is decidedly unpleasing in the high lead enamels and this factor is not in-

dicated by values in Fig. 2. The color advantages in favor of ZnO and BaO are, therefore, much greater than the plotted results indicate.

(d) Fusibility In Fig. 3 are shown the results of cone fusion tests made on enamels of the triaxial field. It was presumed at the outset that there might be a eutectic composition within the field which would compare with a high lead enamel in fusibility. The existence of such a composition would then permit the use of some ZnO and BaO in order to overcome the poor color and brightness of high lead enamels. The points examined disclosed the presence of no such eutectic.

ZnO and BaO appear to have closely comparable effects on fusibility. Substitution of PbO for either or for combinations of the two results in a progressive increase in fusibility.

V. Summary

(1) The following composition is suggested as one to which an acid-resistant enamel should agree in many respects:

	(%)		(%)
Na_2O	18	SiO_2	42
B_2O_3	5	Sb_2O_3	10
CaO	4	BaO }	
CaF_2	1	PbO }	14
TiO_2	6	ZnO }	
			100

(2) This composition containing 14% ZnO or 14% PbO, or any combination of these, smelts satisfactorily. Enamels containing 5% or more of BaO have poor smelting properties.

(3) Considering acid resistance, the amount of ZnO permissible depends upon the criterion used. The 7% citric acid test would permit up to 8% ZnO. The 7% HCl test would permit about 6% ZnO. The latter percentage agrees with the ZnO content of satisfactory enamels developed by Andrews. BaO and PbO are about equal and have no adverse effect on acid resistance.

(4) ZnO and PbO produce better gloss than BaO.

(5) Color and brightness may be greatly improved by substitution of ZnO and (or) BaO, but preferably ZnO, for PbO.

(6) ZnO and BaO have about equal effects on fusibility. The fluxing effect of PbO is more pronounced.

(7) The proper combination of ZnO, BaO, and PbO must be determined by consideration of the acid resistance, fusibility, color, and brightness requirements of an enamel. Each appears to contribute desirable properties. A desirable balance of these constituents in an enamel appears to be approximately 5% ZnO, 2% BaO, and 7% PbO.

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RELATION OF COEFFICIENT OF EXPANSION TO CROSS-BENDING STRENGTH OF SHEET-STEEL ENAMELS[1]

By Murray C. Gautsch

ABSTRACT

Two series of enamels were made with calculated cubical coefficients of expansion varying from 361 to 306. In both series of enamels, the cross-bending values were inversely proportional to the coefficient of expansion. This is due to the fact that all enamels on sheet steel have lower coefficients of thermal expansion than steel. In cooling, after the enamel is fused to the metal, strains are set up in the enamel; the lower the expansion of the enamel the greater the strains. When the enameled piece is bent, the greater the stresses present, the farther the pieces can be bent before there is any real tensile strain on the enamel. High bending abilit ' is dependent primarily on high compressive strains induced by lower coefficient of expansion of the enamel than of the metal base. Compressive strains cause warping, fishscaling (in ground coat), and chipping; therefore the bending strength should not be too high. In all control work both the minimum and the maximum bending strength should be specified.

I. Introduction

Among the problems in the physics of enamels which have been studied in this laboratory is the relation between the coefficient of thermal expansion of enamels on sheet steel and their strength in the cross-bending test. This work is not finished, but some of the results obtained are of enough value to present at this time.

The accumulated results of cross-bending tests on a large number of enamels indicated that any enamel with a low coefficient of expansion would give high values in this test. But after observing the unsatisfactory results obtained on flat ware in commercial practice with enamels of low expansion, it was decided that only a systematic study could show the relations existing between expansion of enamels and the value obtained in the cross-bending test.

II. Experimental

To study the relation between coefficient of expansion and cross-bending strength two series of enamels were planned. Both series of four enamels had a range of coefficients of expansion from 361 × 10,000,000 to 306 × 10,000,000, decreasing in increments of 18.5 from enamels CB-1 to CB-4 and CB-1 to CB-7.

The decrease of expansion in Series I was obtained by increasing the silica content and decreasing the sodium oxide content.

The expansion of enamels of Series II was decreased by increasing the boric oxide content and decreasing the cryolite content.

The melted and batch compositions of the above enamels will be found in Table I with the calculated coefficient of expansion for each enamel.

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Enamel Division). Received March 19, 1931.

The factors used in calculating the coefficients of thermal expansion are:

Feldspar	2.6*	Fluorspar	2.5
Flint	0.8	Cryolite	7.4
Boric oxide	0.1	Zinc oxide	2.1
Sodium oxide	10.0	Sodium antimonate	4.0

* Calculated from analysis.

All the frits were smelted in a 50-pound batch rotary smelter under conditions simulating commercial practice. The enamels were milled so that from 7 to 11 grams of frit were retained on a 200-mesh screen from 100 grams of frit under the standard method of testing adopted by the Enamel Division of the American Ceramic Society.[2] The enamel was applied by spraying two 2- by 12-inch twenty-gage test strips which had been previously coated on both faces with a commercial ground coat.

TABLE I

Melted Weights

	Series I				Series II			
	CB-1	CB-2	CB-3	CB-4	CB-1	CB-5	CB-6	CB-7
Feldspar	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Flint	20.0	22.0	24.0	26.0	20.0	20.0	20.0	20.0
B_2O_3	8.0	8.0	8.0	8.0	8.0	10.5	13.0	15.5
Na_2O	12.0	10.0	8.0	6.0	12.0	12.0	12.0	12.0
Cryolite	12.5	12.5	12.5	12.5	12.5	10.0	7.5	5.0
Fluorspar	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Zinc oxide	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Sodium antimonate	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Calculated coefficient of expansion × 10,000,000	361	342.5	324	306	361	342.5	324	306

Batch Weights

	Series I				Series II			
	CB-1	CB-2	CB-3	CB-4	CB-1	CB-5	CB-6	CB-7
Feldspar	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Flint	20.0	22.0	24.0	26.0	20.0	20.0	20.0	20.0
Borax	21.8	21.8	21.8	21.8	21.8	28.6	35.5	42.3
Soda niter	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Soda ash	12.4	9.0	5.5	2.1	12.4	10.5	8.6	6.7
Cryolite	12.5	12.5	12.5	12.5	12.5	10.0	7.5	5.0
Fluorspar	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Zinc oxide	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Sodium antimonate	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0

One series of tests was run with the strips coated on the face only and another series with enamel on both sides of the strip. In each case the strips were made with two coats of enamel.

The total weight of enamel applied to pieces coated on the face was 8.5 grams, 4.25 grams being applied on each coat. The allowable variation was ±0.1 gram.

The total weight of enamel put on strips which were coated on both sides was 17.0 ± 0.25 gram with 8.5 grams on each side of the strip.

[2] *Bull. Amer. Ceram. Soc.*, **9** [9], 269–71 (1930).

The strips were tested in the Lindemann-Danielson cross-bending machine according to tentative methods proposed by the Committee on Standards of the Enamel Division, American Ceramic Society.[3]

III. Results

The values obtained in the tests of enamels of the two series are given in Table II and are expressed in inches of deflection necessary to cause failure by cracking of the enamel across the upper face of the strip.

TABLE II

DEFLECTION IN INCHES FOR FAILURE OF PIECE

	Series I				Series II			
	Strips coated on face							
	CB-1	CB-2	CB-3	CB-4	CB-1	CB-5	CB-6	CB-7
Trial 1	0.30	0.36	0.42	0.46	0.30	0.36	0.42	0.50
Trial 2	0.28	0.34	0.44	0.50	0.28	0.34	0.42	0.46
Trial 3	0.28	0.36	0.44	0.50	0.28	0.34	0.42	0.50
	Strips coated on both sides							
Trial 1	0.26	0.38	0.44	0.52	0.26	0.34	0.44	0.48
Trial 2	0.28	0.38	0.42	0.52	0.28	0.38	0.46	0.48
Trial 3	0.28	0.38	0.44	0.52	0.28	0.36	0.44	0.50
Average	0.28	0.37	0.43	0.50	0.28	0.35	0.44	0.49
Coefficient of expansion × 10,000,000	361	342.5	324	306	361	342.5	324	306

The curve in Fig. 1 shows that in both series of enamels the cross-bending values are inversely proportional to the coefficients of expansion of the enamels.

The method by which the coefficient of expansion is varied has no effect on the cross-bending value, as the enamels with corresponding coefficients of expansion in each series have the same values in the cross-bending test within the limits of experimental error.

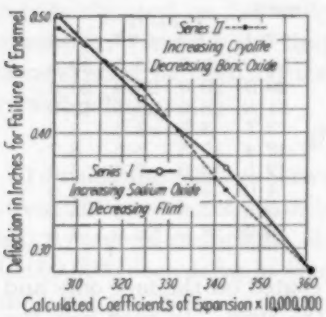

FIG. 1.

The strips which were coated with enamel on both sides had practically the same values as those coated only on one side (see Fig. 2). The only apparent difference in the strips was that those strips coated on two sides did not warp while the strips coated only on one side and with enamels of lower expansion warped.

IV. Summary and Conclusions

This work has shown that when tested under the same conditions, the cross-bending strengths of enamels on sheet steel vary inversely as their coefficients of expansion. This is due to the fact that all enamels on sheet

steel have lower coefficients of thermal expansion than steel. Therefore during the cooling period, after the enamel is fused to the metal, compression strains are set up in the enamel, and the lower the coefficient of expansion of the enamel the greater are these stresses. When the enamel piece is bent, the stresses in the enamel on the convex surface are relieved, and the greater the stresses present, the farther the pieces can be bent before there is any real tensile strain on the enamel.

Since high bending ability is dependent so largely on high compression strains and these same strains tend to cause warping, chipping, and fishscaling (in ground-coat enamels), it is easy to see why enamels with extremely high cross-bending strength have not proved successful in plant practice.

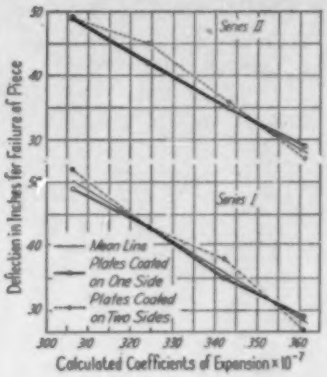

FIG. 2.

In enamels on nonrigid metals, the glasses worked with are necessarily under a certain amount of compression strain. If the strain is too great, the enamels will warp the ware, fishscale (in ground coat), and chip; if too small they will not stand bending. Variation in any factor which influences the amount of strain present will have a profound effect on the mechanical properties of the enamel coating. Among such factors may be mentioned relative coefficients of expansion of ground coat, cover enamel and metal base,[3] time, temperature, and degree of smelting of the enamel frits, adherence of ground coat to metal, amount and kind of mill additions, fineness of grinding, number of enamel coats, thickness of enamel coats and metal base, uniformity of enamel coating, method of firing, cooling, and any subsequent annealing operation.[4] In fact, to obtain uniformity in the mechanical properties of the finished enamel, every operation of manufacture from analyzing and testing the raw materials to storing the finished ware must be carefully standardized.

(1) The Lindemann-Danielson cross-bending machine measures the ability of enameled pieces to bend without fracture.

(2) High bending ability is dependent primarily on residual compressive strains induced by lower coefficient of thermal expansion of the enamel than of the metal base.

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[3] R. R. Danielson and B. T. Sweely, "Relations between Composition and Properties of Enamels for Sheet Steel," *Jour. Amer. Ceram. Soc.*, **6** [10], 1011 (1923).

[4] R. R. Danielson and W. H. Souder, "Causes and Control of Fishscaling of Enamels for Sheet Iron and Steel," *Jour. Amer. Ceram. Soc.*, **4**, 620 (1921). The authors have shown that slow cooling and annealing reduce the tendency to fishscaling. They also reduce the ability to withstand bending.

(3) Since compressive strains tend to cause warping, fishscaling (in ground coat), and chipping in commercial enamels the bending strength should not be too high.

(4) In all control work both the minimum and the maximum bending strength should be specified.

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THE RELATION OF FINENESS OF FELDSPAR USED IN COMPOUNDING A PORCELAIN ENAMEL TO RESISTANCE TO DEFLECTION[1]

By Richard H. Türk

ABSTRACT

The effect of changing the fineness of the feldspar in an enamel was investigated, from which test it was concluded that resistance to deflection is lowered about 9% with a slight increase in fusion temperature when substituting 40-mesh (glassmakers') feldspar for 120-mesh feldspar, both of the same chemical composition.

I. Introduction

As feldspars compose a large proportion of an enamel composition, it is natural that an investigation to lower the cost of this material should be conducted. Feldspar producers have offered glassmakers the same feldspar that the enamelers have been using except that it is considerably coarser, being termed 40-mesh feldspar.

As the power required to grind feldspars greatly increases the finer the feldspar is ground, the producers are able to sell the coarse feldspars at a much lower price than they must ask for the finer grindings of the same quality feldspar.

A sample quantity of this glassmakers' feldspar was obtained from one of the grinders.

Tests on a small scale were made of an enamel compounded with 40-mesh feldspar comparing it with an enamel in which the finer-mesh (enamelers') feldspar was used.

Analysis of Feldspars

	40-mesh (%)	120-mesh (%)
SiO_2	67.92	67.64
Al_2O_3	17.25	17.3
Na_2O	2.3	2.11
K_2O	11.44	11.62

Screen Analyses*

Mesh	40-mesh (%)	120-mesh (%)
40	2.9	Trace
60	5.8	0.1
80	8.1	0.5
100	5.0	0.9
140	10.8	4.3
200		6.6

* Determined by procedure outlined by the Feldspar Grinders' Institute.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Enamel Division). Received May 7, 1931.

The formula of the enamel used was as follows:

Feldspar	380	Soda niter	30
Quartz	120	Cryolite	100
Borax	260	Fluorspar	40
Soda ash	30	Antimony oxide	40

II. Result of Tests

(1) Comparative Refractoriness Results as far as could be determined were about equal, except that the enamel made of the coarser feldspar was slightly more refractory. No direct attempt was made to determine this increase but it was noticeable when small pellets of the two enamels were made and fused down, one beside the other. These pellets were made by measuring out a predetermined volume of frit ground through 80-mesh onto a 200-mesh screen, mixing in a few drops of a solution of gum arabic, and then compressing to a standard size.

This difference in fusion, however, was so slight that it was not considered of any great consequence and it was decided to make up production quantities of these enamels, both compounded and smelted in the same manner.

(2) Plant Tests One-thousand pound batches of each were charged into smelters. The temperature was maintained constant by automatic control.

It was found that the smelting time was increased about 4% when using the coarser feldspar.

The first indication of any difference between the batches was noted by the smelter foreman when the glass tests of the enamel containing the coarser feldspar broke up into small pieces upon cooling. These glass tests were obtained by holding an iron rod in the enamel as it poured from the smelter. The test of the enamel containing the finer-mesh feldspar did not break up.

Samples of both smelts of enamel were taken to the laboratory and carefully tested. Fusion tests indicated the same slightly higher refractoriness for the enamel made with the coarser feldspar as was evidenced in the preliminary experiments.

The enamels were both milled in an identical manner and to the same fineness. While there may have been some difference in the grinding time, it was not noticeable on the tests made.

These enamels were then applied upon a sample plate, one on one-half the plate and the other on the opposite half. The enamel was weighed to assure getting the same amount on each test piece.

When the samples were fired there was no noticeable difference in gloss, but the enamel containing the coarser feldspar had slightly less opacity

and the color was, by comparison, slightly grayer. The difference in fusion temperature was not perceptible in the firing of the enamels.

Cross-bending tests were made according to the tentative method of determining the resistance of sheet-iron enamels to deflection. The enamels used in making up these strips were prepared with the same care to

TABLE I

Trial No. 1

Sample No.	14992* First crack	14992* Failure	14973† First crack	14973† Failure
1	20	21	26	27
2	25	25	23	23
3	20	25	27	28
Average	21.7	23.7	25.3	26

Trial No. 2

Sample No.	14992 First crack	14992 Failure	14973 First crack	14973 Failure
1	21	22	20	21
2	21	23	21	25
3	22	23	22	26
Average	21.3	22.7	21	24

Trial No. 3

Sample No.	14992 First crack	14992 Failure	14973 First crack	14973 Failure
1	19	22	19	25
2	24	26	25	27
3	22	23	26	27
Average	21.7	23.7	23.3	26.3

Trial No. 4

Sample No.	14992 First crack	14992 Failure	14973 First crack	14973 Failure
1	17	19	21	26
2	21	25	24	24
3	23	27	27	27
Average	20.3	23.7	24	25.7

*No. 14992, enamel made with glassmakers' feldspar (40-mesh).
†No. 14973, enamel made with regular feldspar (120-mesh).
The above figures should be multiplied by 2 to obtain deflection in one-hundredths of one inch.

assure their being identical in every manner. The ground-coat as well as the cover-coat enamel was of uniform weight. Wet weights were used in spraying these strips, the moisture content of enamel having been determined and the wet weight corrected accordingly.

NOTE: This has been found justifiable as there is an assurance of obtaining samples of absolutely uniform weight. The more common method of carefully spraying a number of samples and then selecting from that number, after firing, those which came within certain limits was found to consume considerably more time and was wasteful of the sample plates.

In order to have an absolute check, six strips were put into the machine at one time, three of each enamel, and they were so placed as to distribute

the different samples evenly between the rolls. The tests were carried out in accordance with the tentative specifications. The results obtained are illustrated in Table I.

Four trials were made. Originally, only two sets of the samples had been made up. To prove the results obtained, two more sets were enameled, results of which are shown in the last two trials in Table I. From the figures obtained, there is no question but that the use of coarser grades of feldspar will decidedly decrease resistance to deflection of an enamel; whether or not to a serious degree is being determined.

It is interesting to note that the average maximum strength developed by the enamel made with the glassmakers' feldspar was equal to the minimum strength developed by the enamel containing the finer-mesh feldspar, taking the average of all the trials.

(3) Check Tests Experiments made with commercial enamels in 1000- and 6000-pound smelter charges checked these results which removes any question as to whether this reduction in deflection resistance was peculiar to this particular enamel composition or whether it was true in general with all enamels having a relatively high feldspar content. No variation was noted due to the size of the batch smelted.

The investigation has not progressed sufficiently to present any further data, but sufficient information has been obtained to warrant careful tests when changing the mesh of feldspar, even though it be chemically of the same quality, to prevent the depreciation of desirable characteristics in an enamel. The true saving is questionable as, undoubtedly, the increase in rejected ware would far offset any such saving in the enamel cost.

This factor alone may not seriously affect an enamel, but it lowers its total strength and makes it less foolproof in the event that some other unfavorable factors turn up.

NOTE: The laboratory of one of the organizations distributing the glassmakers' feldspar has obtained results checking those stated in this paper.

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AUXILIARY FLUXES IN CERAMIC BODIES[1]

By Paul F. Collins[2]

ABSTRACT

Twenty-five synthetic fluxes composed of ceramic materials, compounded in their eutectic proportions and fused to clear glasses, were added to a body of the semivitreous type in varying amounts, and their effect on vitrification was studied. It has been found possible to reduce the feldspar content of such a body to 8% and, by an addition of 2% of auxiliary glass, to develop almost any desired degree of body vitrification between 0.5 and 7.0% at a temperature as low as cone 6.

I. Introduction

(1) Purpose In the manufacture of vitreous ceramic ware, it has been found advantageous to promote either an earlier vitrification or a more complete vitrification of the products through the aid of auxiliary fluxes. To attain this end, the manufacturer in the past has resorted to additions of raw calcium and magnesium carbonate, the use of which has resulted all too frequently in manufacturing difficulties and defective products.

This research has for its purpose the development of a new type of body flux which, though added in small quantities, is capable of exerting a powerful solvent action during the normal process of body vitrification. The proposed auxiliary fluxes are essentially glasses of the simplest type and as added to the normal ceramic body offer a promising method of controlling body vitrification.[3]

(2) Discussion The glass, added as an auxiliary flux to the ceramic body, becomes active at a relatively low temperature and develops a fluidity sufficient to bind together the entire mass. Its activity as a solvent at this early stage in attacking and dissolving surrounding clay depends primarily on the rate of temperature increase. Thus a medium is created which encourages mullite development and growth. Through this combined process of solution and crystallization (mullite crystallizing out leaving a glass less aluminous and more siliceous),

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Received March 23, 1931. Revised copy received August, 1931.

This paper is a résumé of a research conducted at Ohio State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Ohio State University, December, 1930.

[2] Engineering Experiment Station Coöperative Fellow in Ceramics, Ohio State University.

[3] Some of the earliest vitreous ware contained soft glasses which served as body fluxes, but these constituted a major portion of the body mix and should not be confused with the glasses employed in this study which are added to the body in limited amounts.

the viscosity of the solvent is increased, preventing excessive distortion of the ware with further heat treatment.

The feldspar contributes very little to this vitrification process below 1200°C due to the relatively high viscosity of this silicate. When temperatures are reached at which the feldspar constituent begins to function normally as a solvent, it is, in bodies of this type, only secondary in its action (rather than primary as the sole vitrifying agent) and serves to complete the desired degree of body vitrification. The entire vitrification process is thereby completed at temperatures much lower than those normally required.

II. The Auxiliary Flux

(1) Composition The auxiliary fluxes dealt with in this research were chosen from among the more simple low-temperature fusing mixtures of alkalis or alkaline earths and SiO_2 or B_2O_3, and between alkalis or alkaline earths, SiO_2 and B_2O_3 or Al_2O_3 (see Table I). All glasses employed are pyrochemically active below 1210°C, which is distinctly lower than the normal maturing temperatures for ceramic bodies of the semivitreous type.

It is recognized that the resultant glasses may possibly differ from the theoretical composition, due to volatilization and contamination during fusion.

(2) Preparation All mixtures were fused to glasses in fireclay crucibles, with the exception of those compositions containing B_2O_3 which were melted in a platinum crucible. The usual gas-fired pot furnace was employed. The reported fusion temperatures of these mixtures were roughly checked by means of a protected thermocouple placed directly above the mouth of the crucible. Dependent on the viscosity of the resultant glass, cooling was accomplished either by air-chilling or by pouring the glass on to a steel plate. The glasses were cleaned of all foreign matter and ground to pass 150-mesh.

III. Experimental Results

(1) Cone Deformation Study Little has been known of the character or degree of vitrification possible through the addition of glassy fluxes to the ceramic body. Thus a body was chosen which was lower in total clay content than the normal semivitreous body, so that any tendency toward over-vitrification would be noticeably exaggerated. This body has the following composition:

		(%)
(*A*)	Canadian feldspar	16
	Kentucky ball clay	10
	English china clay	35
	Flint	39

TABLE I

COMPOSITIONS OF LOWEST TEMPERATURE MELTING MIXTURES CONSTITUTING THE AUXILIARY FLUXES

Frit No.	Composition	(%)	Temperature (°C)	Reference
(1)	Al_2O_3	5.1	916	A. V. Bleininger, *Trans. Amer. Ceram. Soc.*, **9**, 444 (1907).
	Cryolite	94.9		
(2)	Al_2O_3	10.0	980	*Ibid.*
	Cryolite	90.0		
(3)	Steatite	20.0	1215	W. S. Howat, *Trans. Amer. Ceram. Soc.*, **18**, 488 (1916).
	Maine feldspar	80.0		
(4)	Steatite	20.0	1160	*Ibid.*
	Microcline	80.0		
(5)	Calcite	26.0	1157	F. A. Kirkpatrick, *Trans. Amer. Ceram. Soc.*, **18**, 611 (1916).
	Albite	74.0		
(6)	$CaSiO_3$	20.0	932	R. C. Wallace, *Trans. Ceram. Soc.* [Eng.], **9**, 172 (1909–10).
	Na_2SiO_3	80.0		
(7)	$CaSiO_3$	69.0	1130	*Ibid.*
	Na_2SiO_3	31.0		
(8)	Albite	69.0	1154	A. S. Watts, *Trans. Amer. Ceram. Soc.*, **18**, 637 (1916).
	Microcline	29.0		
(9)	Magnesite	14.0	1185	F. A. Kirkpatrick, *Trans. Amer. Ceram. Soc.*, **18** 613 (1916).
	Albite	86.0		
(10)	BaO	60.0	750	Guertler, *Z. anorg. allgem. Chem.*, **40**, 337.
	B_2O_3	40.0		
(11)	B_2O_3	60.0	995	*Ibid.*
	CaO	40.0		
(12)	CaO	52.0	1070	*Ibid.*
	B_2O_3	48.0		
(13)	$BaSiO_3$	40.0	908	R. C. Wallace, *Trans. Ceram Soc.* [Eng.], **9**, 176 (1909–10).
	Na_2SiO_3	60.0		
(14)	$MgSiO_3$	10.0	921	*Ibid.*
	Na_2SiO_3	90.0		
(15)	0.549 Na_2O 0.217 K_2O 0.256 CaO	0.973 Al_2O_3	5.904 SiO_2 Cone 2	H. H. Hanna, *Trans. Amer. Ceram. Soc.*, **17**, 672 (1915).
(16)	0.40 KNaO 0.30 CaO 0.30 ZnO	0.60 Al_2O_3	3.55 SiO_2 Cone 03	A. S. Watts, *Trans. Amer. Ceram. Soc.*, **18**, 637 (1916).
(17)	K_2O	55.0	780	B. A. Rice, *Jour. Amer. Ceram. Soc.*, **6**, 525 (1923).
	SiO_2	45.0		
(18)	K_2O	17.5	880	*Ibid.*
	SiO_2	82.5		
(19)	K_2O	17.41	870	*Ibid.*
	Al_2O_3	5.16		
	SiO_2	77.43		
(20)	Na_2O	51.5	830	*Ibid.*
	SiO_2	48.5		
(21)	Na_2O	18.4	860	*Ibid.*
	SiO_2	81.6		
(22)	Na_2O	17.55	800	*Ibid.*
	Al_2O_3	5.33		
	SiO_2	77.12		
(23)	BaO	41.05	1230	Hull, Thesis O.S.U. (B. Cer. E.), 1917.
	Al_2O_3	8.93		
	SiO_2	50.02		
(24)	Na_2O	24.21	570	Kai C. Lu, *Jour. Amer. Ceram. Soc.*, **9** [1], 29 (1925).
	B_2O_3	35.26		
	SiO_2	40.53		
(25)	K_2O	23.70	655	*Ibid.*
	B_2O_3	37.20		
	SiO_2	39.10		

A preliminary study was conducted as a cone deformation study in which the auxiliary fluxes listed in Table I were added to standard body (A) in differing amounts. All these bodies were prepared as small test cones, arranged in a sagger muffle with standard cones and fired to cone 8 in a downdraft, gas-fired, experimental kiln and the rate and temperature of deformation of each cone were noted. Absorption determinations were made on all test cones which did not deform. (See Fig. 1.)

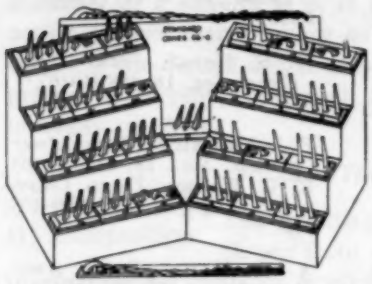

FIG. 1.—Set-up for cone deformation study.

A study of this data indicates which glasses are most active in promoting body vitrification. In most cases, however, this vitrification occurred suddenly and within a short temperature range. Such an occurrence obviously limits the amount of such flux that can be safely used in the ceramic body.

The more promising fluxes (glasses 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 20, 21, 22, 24, and 25) were added to standard body (A) in amounts of 2% and 4%. The physical properties of the resultant bodies fired to cones 3, 6, and 8 were determined.

Volume shrinkage and absorption determinations were made in accordance with the specifications of the Standards Committee of the American Ceramic Society.[3]

Deformation or warpage was determined by the sag developed on firing bars 1/4 by 1 by 6 inches. The principle is the same as that employed in the use of the Holcroft bar as a measure of temperature. (See Fig. 2.)

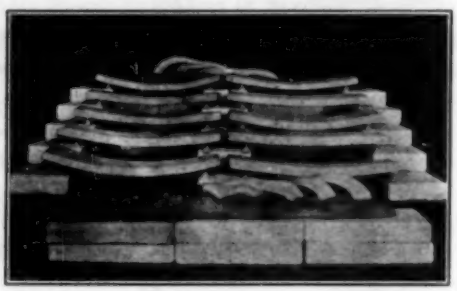

FIG. 2.—Set-up for determination of warpage.

Translucency was determined by the use of wedges, the maximum thickness at which light penetrated being noted. The wedges were passed over an opening 0.002 inch in diameter and 0.50 inch from a 115-volt, 150-watt electric light bulb.

The amount of material which would be dissolved from these eutectic glasses was determined in the usual manner (water solubility). (See Table II.)

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[3] *Jour. Amer. Ceram. Soc.*, 11 [6] 450 and 457 (1928).

(2) Final Studies A study of the data and results presented thus far indicated the following glasses to be most promising as auxiliary fluxes, Nos. 6, 7, 13, 14, 21, and 24.

In making the above selections, such properties as frit solubility, body deformation, and body density were not considered of equal importance. Deformation of body was considered the most serious factor to be dealt with; second in importance, the degree of vitrification developed by the body; and third, frit solubility.

To eliminate the objectionably high water solubility of some of these glasses, they were fused with feldspar. The relative inactivity of the

TABLE II

AMOUNTS OF VARIOUS GLASSES DISSOLVED UNDER STANDARD CONDITIONS

Frit No.	K feldspar added (%)	Parts soluble/ 100 parts water	Grams soluble/ liter of water
	100	0.21	0.516
6	0	90.09	225.240
6	10	5.49	13.716
6	25	3.29	8.224
7	0	0.34	0.836
7	10	0.32	0.796
7	25	0.13	0.340
13	0	15.25	38.156
13	10	5.60	14.004
13	25	3.39	8.497
14	0	100.00**	250.000**
14	10	19.96	49.900
14	25	5.65	14.144
14	35	3.88	9.704
21	0	4.71	12.016
21	10	3.35	8.384
21	25	1.36	3.412
24	0	15.70	39.244
24	10	9.93	24.833
24	25	6.25	15.948

** This indicates that the ratio chosen of weight of solid to volume of solvent, in this case, did not give a saturated solution.

K_2O glasses in the potash feldspar body was observed in the preliminary studies and since all of the above selected glasses contain Na_2O as one ingredient, it was believed that a high potash feldspar would give the more complete reaction. (See Table II.)

TABLE III*A*

Frit. No.	Potash feldspar (%)	Designated as
6	25	6–F–25
7	0	7–F– 0
13	25	13–F–25
14	35	14–F–35
21	10	21–F–10
24	25	24–F–25

The approximate compositions of such mixtures after their fusion with feldspar are given in Table III*B*.

TABLE III*B*

APPROXIMATE FORMULAS OF MIXTURES AFTER FUSION WITH POTASH FELDSPAR

Approximate Formula of Canadian Feldspar Used

$$\left.\begin{matrix}0.6951K_2O\\0.3097Na_2O\\0.0488CaO\end{matrix}\right\} 1.000Al_2O_3 \left\{\begin{matrix}5.972SiO_2\cdot 0.0855H_2O\\ \text{Equivalent weight } 549.13\end{matrix}\right.$$

Formula of Glass No. 6-F-25

$$\left.\begin{matrix}0.0483K_2O\\0.7573Na_2O\\0.1943CaO\end{matrix}\right\} 0.069Al_2O_3 \{ 1.342SiO_2$$

Formula of Glass No. 7-F-0

$$\left.\begin{matrix}0.6078CaO\\0.3021Na_2O\end{matrix}\right\} 1.000SiO_2$$

Formula of Glass No. 13-F-25

$$\left.\begin{matrix}0.0560K_2O\\0.6644Na_2O\\0.0040CaO\\0.2756BaO\end{matrix}\right\} 0.0805Al_2O_3 \{ 1.3954SiO_2$$

Formula of Glass No. 14-F-35

$$\left.\begin{matrix}0.0624K_2O\\0.7915Na_2O\\0.0047CaO\\0.1416MgO\end{matrix}\right\} 0.0898Al_2O_3 \{ 1.4404SiO_2$$

Formula of Glass No. 21-F-10

$$\left.\begin{matrix}0.0401K_2O\\0.9571Na_2O\\0.0028CaO\end{matrix}\right\} 0.0578Al_2O_3 \{ 4.6516SiO_2$$

Formula of Glass No. 24-F-25

$$\left.\begin{matrix}0.0721K_2O\\0.9227Na_2O\\0.0051CaO\end{matrix}\right\} 0.1037Al_2O_3 \left\{\begin{matrix}2.1602SiO_2\\1.1488B_2O_3\end{matrix}\right.$$

IV. Feldspar Frit Glasses in a Typical Semivitreous Body

The feldspar-frit glasses, prepared as shown, were studied in a body higher in total clay content than body (A) and were more nearly representative of the semivitreous type of body. This body had the following composition:

Body B	(%)
Canadian feldspar	12
Kentucky ball clay	15
English china clay	37
Flint	36

The auxiliary fluxes were added in amounts of 2 and 4% and the physical properties of the resultant bodies fired to cones 3, 6, and 9 were determined.

(1) Additional Tests

To demonstrate more clearly the activity of these glassy fluxes as solvents in the ceramic body, they were added to bodies in which the feldspar and flint were varied.

TABLE IV

	Body C (%)	Body D (%)	Body E (%)
Virginia feldspar			10
Canadian feldspar	10	8	
Kentucky ball clay	15	15	15
English china clay	37	37	37
Flint	38	40	38

To the above bodies, frits Nos. 6, 7, 13, 14, 21, and 24 (fused with feldspar as shown in Table III*A*) were added in amounts of 2 and 4% and the

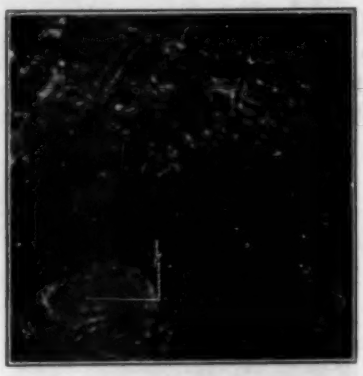

FIG. 3.

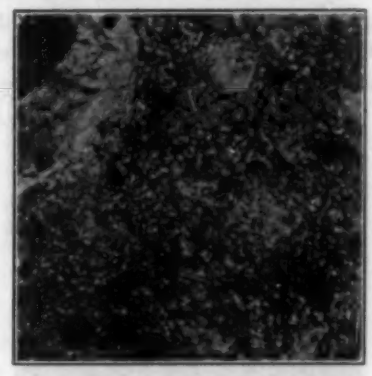

FIG. 4.

FIGS. 3 AND 4.—Thin sections prepared from body (A), fired to cone 8 (1290°C), and containing 4% of glass No. 4.

The auxiliary glass has not diffused and is apparent as isolated glassy areas spread uniformly throughout the body. Its outline is definite and it contains an abundance of fine, needle-like crystals of mullite.

The grain superimposed on the auxiliary glass (in Fig. 3) is feldspar glass, which contains only a limited amount of mullite. The mullite development is noted to be more or less concentrated along the lower edge of the grain, which demonstrates most clearly the nonhomogeneity of such glasses.

physical properties of the resultant bodies fired at cones 3, 6, and 9 were determined.

V. General Conclusions

The adaptability of these glasses as body fluxes and their capacity as solvents in promoting body vitrification cannot be over-emphasized. They are apparent in the fired body as follows:

(1) Isotropic glass of definite outline scattered uniformly throughout the body containing only a limited amount of crystalline material and contributing to body vitrification chiefly by increasing the amount of glass there. (See Figs. 3 and 4.)

(2) Glassy areas of indefinite outline representing a more or less wide

area of attack on surrounding constituents and containing an abundance of well-defined, elongated needles of mullite, indicating the high degree of fluidity attained by these glasses during the process of body vitrification. (See Figs. 5, 6, and 7.)

(3) As a completely diffused glass, indistinguishable in the glassy matrix of the body, yet evidenced there by the network of fine, needle-like crystals in that groundmass. (See Fig. 8.)

Whether a particular glass completely or only partially diffuses into the groundmass of the body or whether it remains *in situ* as isolated glassy areas is dependent solely upon the compatibility or miscibility of the two glassy phases present in this body, *i.e.*, (1) the synthetic glass added to the body and (2) the glass developed in the ceramic body by its body ingredients themselves during the normal firing treatment.

Thus complete miscibility or compatibility of the two glassy phases

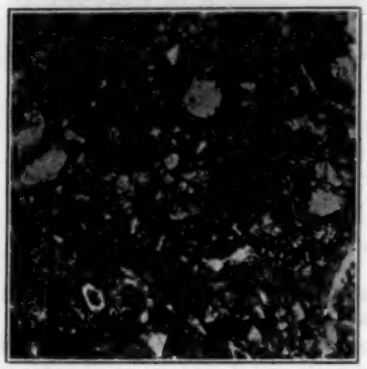

FIG. 5.

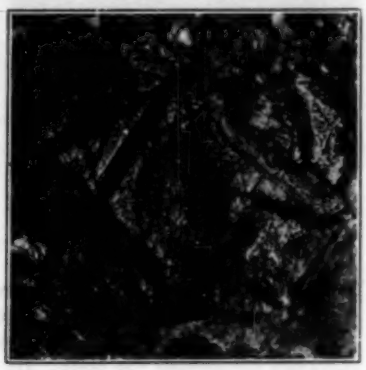

FIG. 6.

FIG. 5.—Thin section prepared from body (A), fired to cone 8 (1290°C), and containing 2% of glass No. 7.

The outlines of the original glassy grains are only roughly indicated. The glassy areas are observed to contain a haphazard growth of well-defined, elongated needles of mullite. From the size of crystals here developed, it would seem to indicate that this glassy flux had become quite fluid in the firing treatment of the body.

Surrounding each mass of crystallization, there is a narrow border of clear, isotropic glass. The smoothness of contour of the crystallization areas are thought to be due to the attack and resorption of the crystals by the glassy phase surrounding them. This phenomenon has been observed to occur in the case of several of the glassy fluxes as well as in the feldspar glass.

FIG. 6.—Thin section prepared from body (A), fired to cone 8 (1290°C) and containing 4% of glass No. 3, and viewed under an oil immersion lens.

The grain of auxiliary glass contains an abundance of fine, needle-like crystals, which radiate from various nuclei and penetrate inward from the irregular boundary of the glassy area. The mass of crystallization is surrounded by a narrow glassy border, which is apparently attacking and resorbing the crystalline phase present.

would give a body structure as pictured in Fig. 8, while incompatibility would seem to give body structures as pictured in Figs. 4, 5, and 7.

Each type of body structure has its advantages and limitations. Only a more extensive study could definitely decide this question.

An addition of auxiliary glass in excess of 4% to a body of the semi-

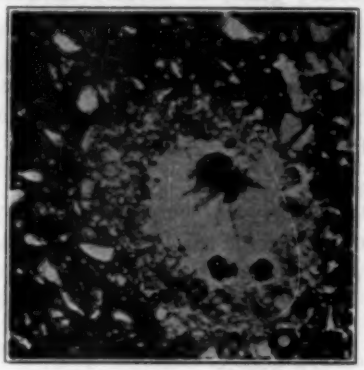

FIG. 7.

FIG. 8.

FIG. 7.—Thin section prepared from body (A), fired to cone 8 (1290°C) and containing 2% of glass No. 13.

The auxiliary flux in this section has for the most part completely diffused into the groundmass resulting in a highly glassy groundmass. In a few instances its identity has not been lost entirely and appears as shown in the figure. Note the wide area of attack and diffusion. Does this indicate that with increased temperature this glassy flux becomes quite fluid, diffuses into the groundmass, functions as a solvent, and deposits mullite from this enrichened media? Or does this represent a further step in the process, namely, an almost complete resorption of the crystalline phase present with simultaneous diffusion into the groundmass?

FIG. 8.—Thin section prepared from body (A), fired to cone 8 (1290°C) and containing 4% of glass No. 5.

This section shows the auxiliary glass to have diffused completely into the groundmass of the body and to have aided there in the development of a framework or skeleton of very fine, elongated, needle-like crystals. There are no isolated glassy areas in this section.

Sections of body (A) containing 2% of glass No. 6 and 4% of glass No. 7 appear quite similar to this general type. The groundmass contains the same characteristic crystalline structure and in addition contains numerous glassy areas in which occur very minute needle-like crystals. In such glassy areas pressure cracks are quite numerous and must have resulted in the course of the normal firing treatment or as a result of forces which could have originated as a result of massive crystallization. Would this tend to put the entire body under strain?

Sections containing fluxes Nos. 22 and 24 in body (A) show the auxiliary glass to have diffused again into the groundmass in most cases, but there is no evidence of crystallization in the groundmass.

vitreous type, containing 12 to 16% feldspar, invariably produces excessive warpage.

Fusion of the glasses with feldspar prior to introduction into the body mix does not lessen their activity as auxiliary fluxes in that body.

It has been found possible to reduce the feldspar content of body B to 8% and by an addition of 2% of auxiliary glass, to develop almost any desired degree of body vitrification between 0.50 and 7.0% at a temperature as low as cone 6 (1250°C).

At cone 6 this new body has an increased translucency of approximately 30% over that of the normal semivitreous body. Its deformation (tendency toward warpage) has not been affected and the total shrinkage does not exceed 11%.

The above-mentioned bodies were prepared in large batches, successfully jiggered into 5-inch plates, biscuited at cone 6, and glazed at cones 2 to 3.

Formula of Glaze Used

Glaze

$$\left.\begin{matrix}0.202PbO\\0.168K_2O\\0.020Na_2O\\0.450CaO\\0.160ZnO\end{matrix}\right\}\ 0.228Al_2O_3\ \left\{\begin{matrix}2.220SiO_2\\0.285B_2O_3\end{matrix}\right.$$

Frit

$$\left.\begin{matrix}0.020Na_2O\\0.021CaO\end{matrix}\right\}\ 0.0256Al_2O_3\ \left\{\begin{matrix}1.146SiO_2\\0.285B_2O_3\end{matrix}\right.$$

TABLE V

Body	Flux	Cone	Deformation (in.)	Absorption (%)	Translucency (in.)
B	None	9	0.35	4.60	0.150
D	None	9	0.31	5.29	0.143
D	2% 6-F-25	6	0.25	1.52	0.192
D	2% 7-F-0	6	0.25	0.52	0.198
D	2% 13-F-25	6	0.29	4.96	0.193

It appears possible to substitute other feldspars, *i.e.*, Virginia feldspar for Canadian feldspar, without affecting the activity of the auxiliary glasses or materially affecting the physical properties of the body. (Compare bodies D and E.)

This fact would seem to support the evidence that the auxiliary glass serves as the primary vitrifying agent or solvent and that the particular feldspar used is of minor importance and probably serves only as a source for glass development in the final stages of vitrification.

Furthermore, there was no evidence of increased distortion of the ware during the glaze fire which indicated that the glassy solvent had become saturated and rendered relatively inert prior to cone 6, the maturing temperature of these new bodies.

The cost of raw materials involved in these glasses does not exceed 2

cents per pound and the cost of preparing, fusing, and grinding should be approximately 4 cents per pound. Since these glasses are added to the body in amounts of only 2% (40 lb. glass per 2000 lb. of body), they would increase the cost of body preparation about $1.60 per ton.

Other commercial features of such additions to the ceramic body are as follows:

(1) Less fuel consumption; maturing temperature of body reduced from cone 9 to cone 6.

(2) Reduction in body cost; feldspar content of body may be reduced to 8%, flint content accordingly increased. Feldspar is quoted at $18.00 per ton and flint at $10.00 per ton.

(3) A reduction in cost of saggers, since special refractory clays need not be employed for service at cone 6.

(4) A saving in kiln refractories which are spared the corrosive action of high temperatures endured over longer periods of time.

(5) Greater turnover per kiln, increased output due to shorter firing schedule, and reduction in total time of firing and cooling.

Acknowledgment The author wishes to offer acknowledgment to Arthur S. Watts, Chairman of the Ceramic Engineering Department of the Ohio State University, who recommended and, with T. A. Klinefelter of the Columbus Branch of the Bureau of Standards, jointly directed this research.

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A CONE NINE VITRIFIED FLOOR TILE BODY[1]

By F. A. Kirkpatrick and W. E. Williams

ABSTRACT

A group of twenty-eight floor tile bodies in a triaxial field was studied experimentally for the purpose of developing a vitrified, non-staining tile at cone 9.

I. Introduction

The problem of this investigation was to produce a vitrified floor tile of the "ceramic" type, made in small sizes, generally not over two inches in any dimension. Such a tile must be accurate in dimension, strong mechanically, hard in texture, of reasonably white color, and sufficiently vitrified and surfaced to prevent staining.

The work here reported deals chiefly with the relations between composition, porosity, staining, and maturing temperatures.

II. Method of Preparation

One kilogram of each body was weighed into a porcelain mill and ground one hour with one liter of water. The slip was dried in a gas oven and the dust reduced in an impact grinder and screened through a 20-mesh screen. Water was then mixed with the dust for pressing, the amount approximating 8%. Pressing was done in a hand press, the plunger being impounded three times as is customary in hand-press work. A stock die was used, making a tile $2^3/_{16}$ by $2^3/_{16}$ inches and $^1/_4$ inch thick. The die parts were not specially surfaced for producing smooth tile.

Since the amount of grinding is important, it should be mentioned that the one-hour grind in a small mill was found to produce approximately the same degree of fineness as a six-hour grind in a large production mill.

III. Placing and Firing

The tile were placed face to face in the sagger and set on edge in sand. They were then completely covered with sand. Orton cones were placed in each sagger. The saggers were placed 4, 8, and 18 high in the second ring of a white wall-tile bisque kiln with a regular charge of production ware. The kiln was an 18-foot potter's kiln with downdraft circulation, having a capacity of 2000 saggers, 8 by 10 by 18 inches in size. Firing was carried out on a four-day schedule using coal as fuel. The kiln atmosphere was predominantly oxidizing throughout the firing, although there was some reduction at times. The cooling period was three days.

IV. Raw Materials

One kind of feldspar and one kind of flint comprised the nonplastic

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division).

portion of the bodies. The clay content was composed of 16% Kentucky ball clay, 64% English china clay, and 20% Florida kaolin. The silica and alumina contents of the clays are approximately as follows:

	Silica (%)	Alumina (%)
Kentucky ball clay	52	32
English china clay	47	38
Florida kaolin	46	38

Tennessee feldspar was used, the composition being designated as 67–41 in the U. S. Bureau of Standards symbols, meaning 66 to 67.99% of silica and approximately 4 parts of potash to one part of soda.

TABLE I

COMPOSITION AND ABSORPTION OF BODIES

Body Number	16	17	18	19	20	21	22
Flint	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Feldspar	55.0	50.0	45.0	40.0	35.0	30.0	25.0
Kentucky ball clay	3.2	4.0	4.8	5.6	6.4	7.2	8.0
English china clay	12.8	16.0	19.2	22.4	25.6	28.8	32.0
Florida kaolin	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Absorption							
Cone 6	0.0	0.0	1.0	2.9	5.2	7.0	8.0
Cone 7	0.0	0.0	0.0	1.5	2.8	4.8	6.0
Cone 9	0.0	0.0	0.0	0.0	1.0	1.9	1.5
Body Number	23	24	25	26	27	28	29
Flint	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Feldspar	60.0	55.0	50.0	45.0	40.0	35.0	30.0
Kentucky ball clay	3.2	4.0	4.8	5.6	6.4	7.2	8.0
English china clay	12.8	16.0	19.2	22.4	25.6	28.8	32.0
Florida kaolin	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Absorption							
Cone 6	0.0	0.0	0.0	0.0	1.5	3.4	4.8
Cone 7	0.0	0.0	0.0	0.0	0.0	2.0	3.6
Cone 9	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Body Number	30	31	32	33	34	35	36
Flint	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Feldspar	65.0	60.0	55.0	50.0	45.0	40.0	35.0
Kentucky ball clay	3.2	4.0	4.8	5.6	6.4	7.2	8.0
English china clay	12.8	16.0	19.2	22.4	25.6	28.8	32.0
Florida kaolin	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Absorption							
Cone 6	0.0	0.0	0.0	0.5	2.0	4.2	4 9
Cone 7	0.0	0.0	0.0	0.0	0.9	1.8	3.4
Cone 9	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Body Number	37	38	39	40	41	42	43
Flint	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Feldspar	70.0	65.0	60.0	55.0	50.0	45.0	40.0
Kentucky ball clay	3.2	4.0	4.8	5.6	6.4	7.2	8.0
English china clay	12.8	16.0	19.2	22.4	25.6	28.8	32.0
Florida kaolin	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Absorption							
Cone 6	0.0	0.0	0.0	0.0	1.0	1.5	3.6
Cone 7	0.0	0.0	0.0	0.0	0.5	0.5	2.0
Cone 9	0.0	0.0	0.0	0.0	0.0	0.0	0.5

The flint used was ground Pennsylvania quartz rock. Screen analyses of the flint and the feldspar are as follows:

Per Cent	Flint	Feldspar
Residue on 115-mesh	0.3	0.1
" " 150- "	0.4	0.1
" " 170- "	0.7	1.0
" " 200- "	1.2	1.4
" " 270- "	2.2	3.0
Pass the 270- "	95.2	94.4
Grand total	100.0	100.0

V. Body Compositions and Results

In Fig. 1 is shown the location of the body compositions in a triaxial diagram. The field is shown within the boundaries designated by the bodies 16, 22, 43, and 37. The clay content varies from 20% at the left side of the area to 50% at the right. The flint content varies from 10% at the bottom of the area to 25% at the top. The feldspar content varies from 25% in body No. 22 to 70% in body No. 37.

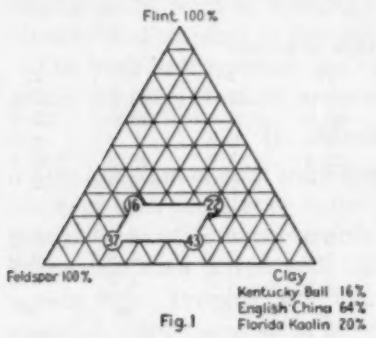


Fig. 1

In Table I are given the batch compositions and the absorption of the bodies at cones 6, 7, and 9. The absorption was determined by boiling two hours in water, five tile of each body being used. Absorption is shown graphically in Figs. 2, 3, and 4 for cones 6, 7, and 9, respectively. As already stated, the three heat treatments were secured in one firing by placing the tile at different heights in the kiln, thus subjecting them to an identical firing schedule. The value of the absorption data was found to be limited to an indication of the maturing range of firing, as some bodies showing zero absorption stained when ink was applied. Hence it was necessary to use a stain test to make the final choice of bodies. Evidently the two-hour boiling treatment was not sufficient to saturate the pores of the tile. The absorption figures show, however, that the bodies used are immature at cones 6 and 7 and require the heat

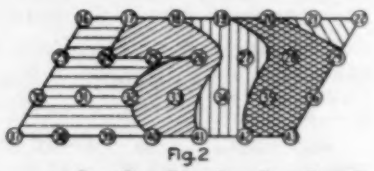


Fig. 2

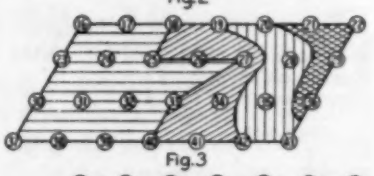


Fig. 3

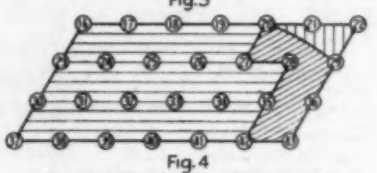
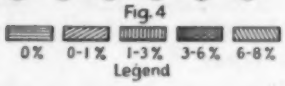


Fig. 4



of cone 9 to produce any desirable tile. The degree of vitrification was closely proportional to the feldspar content for any one flint content, but the rate varied from one flint content to another.

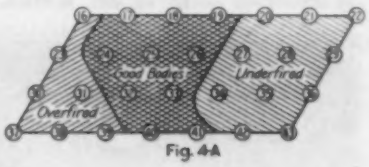


Fig. 4A

Visual observation of the tile fired to cone 9 gave the results shown in Fig. 4A. The tile in the overfired area were gray in color, had glossy surfaces and pimples, and stuck together in firing. Tile in the area of good bodies were white in color, had no pimples, and did not stick together. Tile in the underfired area were of a cream color and somewhat stony in appearance. In addition to the above defects, bodies 30, 37, and 38 with high-feldspar content warped considerably. These bodies were objectionable also on account of being tender in the green state due to the high nonplastic content.

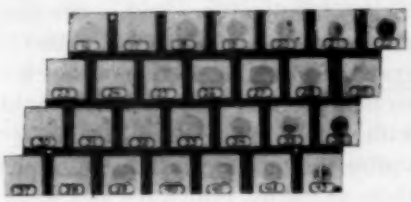


Fig. 5.

An ink-stain test was made on the tile from each of the three firing temperatures. This was done by applying to the surface of the tile 0.2 cc. of Carter's blue-black ink. This ink, containing both finely-divided carbon and a soluble dye, provides an effective staining agent. The ink was allowed to dry thoroughly and then the surface of the tile was washed and scrubbed with water.

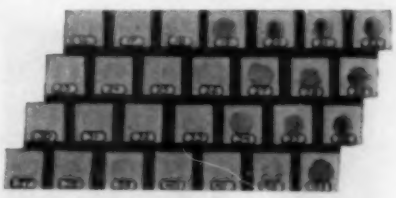


Fig. 6.

The appearance of the tile after this treatment is shown in Figs. 5, 6, and 7 for the tile fired to cones 6, 7, and 9, respectively. At cones 6 and 7 the only tile free of stain were overfired, hence not desirable. At cone 9 about half of the bodies were free of stain. Of these, the most satisfactory were Nos. 25, 26, 32, and 33.

Fig. 7.

The results indicate that still better tile may be obtained by further manipulation of the raw materials, especially the "kind" of feldspar and clay. Any raw material would be desirable which would tend to give a smooth, impervious surface without causing overfiring of the body.

VI. Microstructure of the Bodies

As a matter of general interest, a brief study was made of the microstructure of some of the bodies. Figures 8 and 9 are photomicrographs of a thin section of body No. 26 fired to cone 9.

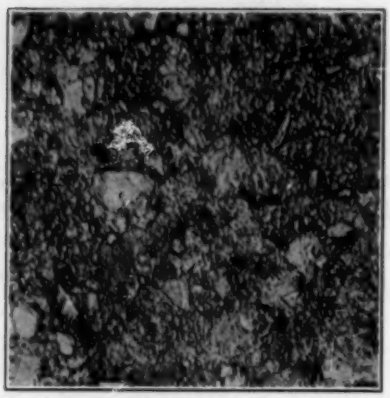


FIG. 8.

Figure 8 shows the structure in plane polarized light at a magnification of 160 diameters, indicating the presence of a large amount of granular material, a quite different condition from that of a porcelain fired to higher temperatures and consisting mostly of glass. Figure 9 is a photograph of the same portion of the thin section taken in plane polarized light with nicols crossed. This leaves visible the quartz particles of which there are many, both large and small. What detrimental effect the quartz would have upon the properties of the tile would be a difficult question to answer without extensive study. Floor tile are liable to be used where they are subject to sudden changes in temperature and crystalline quartz is of no assistance in resisting such conditions. It should be possible to dissolve most of the quartz by use of a suitable flux in the body and perhaps by a higher temperature of firing.

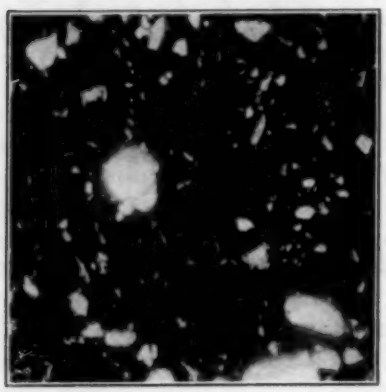


FIG. 9.

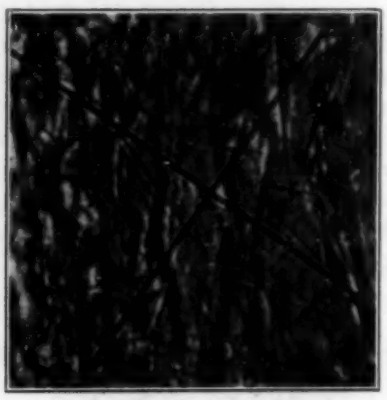


FIG. 10.

In Fig. 10 is shown a photomicrograph of the cone 9, No. 26 body obtained in plane polarized light at a magnification of 1250 diameters and secured by use of the oil-immersion method. A mineral fragment at the

center of the photograph has apparently changed to the needle-like mullite crystals. Such crystals are seen also in a smaller fragment in the corner of the photograph. There were found only a few of such patches of crystals, not enough, probably, to affect greatly the physical properties of the tile. The photograph leads one, however, to wish for more raw material of the mullite type in tile; material which resists warping and expansion.

Thin sections were made of eleven of the cone 9 bodies. The amount of undissolved quartz appeared about alike in all of the bodies, there being more in those bodies with higher original flint content. All appeared much alike and similar to the photographs of body No. 26. Even in body No. 37 with 70% feldspar the quartz appeared to have undergone very little solution.

VII. Conclusions

From a field of 28 triaxial bodies, four were selected as being the most suitable for vitrified floor tile at cone 9. The compositions are as follows:

	No. 25	No. 26	No. 32	No. 33
Flint	20.0	20.0	15.0	15.0
Feldspar	50.0	45.0	55.0	50.0
Kentucky ball clay	4.8	5.6	4.8	5.6
English china clay	19.2	22.4	19.2	22.4
Florida kaolin	6.0	7.0	6.0	7.0

Tile of these compositions did not stain with application of a blue-black writing ink. These bodies were found suitable for use as colored tile when proper allowance was made for the effect of the coloring oxide upon the vitrification of the body.

Acknowledgment The writers wish to thank R. E. Lowrance for the use of the data of this paper and to thank E. W. Tillotson and members of the staff of Mellon Institute of Pittsburgh for the photomicrographs.

SIMPLIFICATION OF THE RING METHOD FOR DETERMINING GLAZE STRESSES[1]

By H. E. Davis and R. L. Luebers

ABSTRACT

This work was undertaken to develop a ring for the determination of glaze stresses which would show movements great enough to be measured with a micrometer caliper. The 3-inch diameter ring developed makes quick measurements possible without the use of the micrometer microscope necessary with the 2-inch rings.

I. Introduction

A method has been developed for determining the differences in coefficient of expansion between body and glaze quickly and easily and has been found to be of great assistance to the manufacturer. This method undertaken by H. G. Schurecht and G. R. Pole[2] is given briefly as follows:

A cylinder is prepared, 2 inches outside diameter, 3/4 inch high, and 1/4 inch in wall thickness. The outside periphery only is coated with the glaze to be tested and fired in the usual commercial manner. After firing, two reference grooves are cut parallel across the edge of the ring, about 1/4 inch apart, and into these grooves are cemented short capillary tubes, about 1/8 inch long and 1/32 inch in diameter. The distance between these is measured accurately with a micrometer microscope. Cutting the ring between these reference marks with a diamond saw or narrow Crystalon wheel permits the ring to contract or expand as the case may be. The distance between the reference marks is again measured and this difference is the amount of contraction or expansion. Decrease of the distance indicates a glaze or coating under compression, while an increase indicates tension.

II. The Larger Ring

The mechanics of this method indicate that considerably greater difference could be obtained by increasing the ring diameter. In the work reported by Schurecht and Pole, the movements within the range of satisfactory glaze and slip composition were only from 0.0 to 0.03 cm. It is obvious that sufficiently accurate measurements could be made only with a microscope. Accordingly, a ring with a 3-inch outside diameter was prepared, being the same in all other dimensions, with the addition of a lug 1/4 inch high and 1/2 inch long as shown in Fig. 1.

This method was decided upon after several unsuccessful attempts to cement metal reference points onto the straight ring. A model was prepared according to these specifications and plaster molds were made. Needless to say, such a piece is very tender to make and to handle and should be pressed with the greatest care to insure the utmost homogeneity.

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Terra Cotta Division).

[2] "Method of Measuring Strains between Glazes and Ceramic Bodies," *Jour. Amer. Ceram. Soc.*, 13 [6], 369–75 (1930).

A brass mold would be preferable as it would eliminate variations in thickness due to the rapid wearing of the plaster.

When the outside surface of the ring has been sprayed preparatory to firing, reference points are applied in the form of glaze beads on opposite ends of the $^1/_2$-inch lug, care being taken to keep them in the same plane and concentric with the circumference. These beads are applied as globules from the tip of a small brush, and a viscous glaze must be employed to avoid flowing in the firing process. These beads fuse to a rather perfect hemisphere of approximately $^1/_{16}$ inch diameter.

III. Measurement of Contraction or Expansion

The distance between the reference points on the fired specimens is determined with a ratchet micrometer caliper graduated in the metric system. The rings are then sawed through between the reference points with a narrow blade abrasive wheel and the distance is again measured, the distance between these two readings being the amount of contraction or expansion. In the testing of nearly 200 specimens, the minimum difference was approximately 0.011 cm. and the maximum 0.088 cm., as compared with the readings of Schurecht and Pole with similar glazes of 0.008 cm. minimum and 0.016 cm. maximum. The minimum reading of 0.011 cm. of the 3-inch ring was obtained with a glaze having a much greater tendency to craze than the one producing the minimum of 0.008 cm. on the 2-inch ring. An actual comparison is as follows:

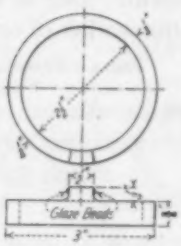


FIG. 1.

	2-in. ring	3-in. ring
1 bright glaze	0.0087	0.0335

Generally speaking, the ratio is about 4 to 1.

IV. Important Factors in Preparation of Specimens

As previously mentioned, the rapid wearing of the plaster mold must be taken into consideration, as it permits a gradual increase of the wall thickness, which of course would affect the results. It is therefore necessary to renew molds frequently if plaster molds are being used. It is also essential that thickness of the glaze coating be as uniform as possible on all specimens and on the entire circumference of individual samples. This has been satisfactorily accomplished by the use of a small hand-rotated spindle. The following table shows the results obtained by spraying one, two, and three coats of white mat glaze on three coats of a given underslip:

Coat No.	(cm.)
1	0.045
2	0.058
3	0.071

Undoubtedly the perfect accuracy of this test was largely accidental but the indication is nevertheless positive.

V. Conclusions

Contractions of no more than 0.03 cm. with the 3-inch ring indicate a glaze with a strong tendency toward crazing as shown by the autoclave treatment. On the other hand, contractions up to nearly 0.09 cm. have been accompanied by no shivering tendencies whatever on a large commercial scale. This gives a safe working range between 0.035 cm. and 0.09 cm., with 0.06 cm. being considered satisfactory.

It is evident that the larger ring produces movements great enough to be easily and quickly measured with an ordinary micrometer caliper, eliminating the necessity of investing in rather expensive microscopic equipment. Due to the simplicity of the necessary apparatus, it is possible for the worker of ordinary intelligence to secure satisfactory results.

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COLOR FORMATION IN RAW LEAD GLAZES[1]

By D. Te Hui Shaw

ABSTRACT

Various amounts of practically all of the chromatic elements in the periodic system were introduced individually into a simple lead silicate glaze, and the resulting glazes were analyzed for color with an automatically recording photoelectric color analyzer. The spectrophotometric data were then converted into trichromatic and monochromatic specifications of color. An empirical relationship was then determined between the concentration of the chromatic element and the three attributes of color: hue, saturation, and brilliance. The effect of glaze thickness on color was also studied. It was found that the same laws connecting concentration of the coloring element with the three attributes of color held for all the elements used. A number of elements not previously mentioned in the literature as color-producing agents were found to give interesting colored glazes. In several cases an element was added to the base glaze in various forms, such as nitrates, chlorides, and oxides. If equivalent amounts were added, the color in all cases was the same regardless of the colorless radical.

I. Introduction

The scanty knowledge of the fundamental principles of color formation existing in the field of ceramics has prompted this investigation, which attempts to determine in a simple lead glaze the following points:

(1) The specific color effects of various elements.
(2) Some fundamental factors affecting color formation of a given element.
(3) The general laws connecting the concentration of the elements with the attributes of color.
(4) The mechanism of color formation.

Only the effects of single elements are discussed here and those of mixtures of elements will be studied later.

II. Review of Literature

(1) Color of the Elements Fritz Ephraim[2] observed that the atomic numbers which give colored ions are in close proximity to each other. In numbers 1 to 21 (H to Sc), the movement of the electrons does not cause any vibration in the visible part of the spectrum, and are therefore colorless. In the elements which follow, the atomic numbers of which range from 22 to 29 (Ti, V, Cr, Mn, Fe, Co, Ni, Cu), these vibrations are present and the result is that these elements are colored, at any rate,

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[1] This is an abstract of a thesis submitted by the author to the Faculty of the Massachusetts Institute of Technology for the partial fulfilment of the requirement for the degree of Doctor of Science. The work was done in the Ceramic Laboratory of the Institute under the supervision of Frederick H. Norton. Received March 23, 1931.

[2] F. Ephraim, A Textbook of Inorganic Chemistry, Gurney & Jackson, London, 1926, English ed., by P. C. L. Thorne, p. 32.

in certain states of valency. Numbers 30 to 40 (Zn to Zr) give colorless ions, 41 to 46 (Cb, Mo, Ru, Rh, Pd) colored, 47 to 56 (Ag to Ba) colorless, etc., etc. The color effects may commence or end in different groups of the periodic system.

Carey Lea,[3] considering the elements and their combination from the point of view of color development, came to the conclusion that the color is a property of first rate importance for the proper classification of the elements. He classified the colorless and colored elements separately in the following two tables similar to the well known Mendeleef's periodic table:

(*a*) Elements with all colorless ions in numerical order forming nine natural groups:

H	F	Cl	Br	I	
Li	Na	K	Rb	Cs	
		Ca	Sr	Ba	
		Sc	Yt	La	
Be	Mg	Zn	Cd	Hg	
B	Al	Ga	In		
C	Si	Ge	Sn	Pb	Th
N	P	As	Sb		
O	S	Se	Te		

(*b*) Elements with ions always colored and also transitional elements in numerical order. (The transitional elements are those which have colored ions at some valences and colorless at others. The italic symbols denote these elements.)

Ti	Cr	*Cu*	*Nb*	Ru	*Ag*	*Ce*	Di	*Ta*	Os	*Ti*	U
V	Mn		*Mo*	Rh			Sm	*W*	Ir	*Bi*	
	Fe			Pd			Er		Pt		
	Co								Au		
	Ni										

Watson[4] after a careful study of the colors of the normal oxides, sulphides, and chlorides in the usual periodic arrangement came to the conclusion that

(1) In any group of the periodic table, color develops as the atomic weight increases.
(2) Neither the strongly positive nor the strongly negative elements show much color development.
(3) Color development reaches a maximum in the eighth group.
(4) In addition, there is a tendency for the development of deep color in the middle of the first double period, *i.e.*, in the elements V, Cr, Mn, Fe, Co, Ni, and Cu, and to a less degree, in the middle of the other long periods.

(2) Color of Glasses and Glazes

According to Ponomarev[5] and many others, the substances producing color within glazes and glasses are divided into two groups:

[3] *Amer. Jour. Sci.*, **49**, 357 (1895).

[4] E. R. Watson, Color in Relation to Chemical Constitution, Longmans, Green & Co., London, 1918 ed., p. 176.

[5] *Zhur. Prikladnoi Fiz.*, **4** [3], 31 (1927); also *Chem. Abs.*, **24**, 2849 (1930).

TABLE I

Sc, Ti, V GROUP

No.	Composition	Batch Weight				$C^1/_3$	Description of Color	Trichromatic			Monochromatic			
		Pb_3O_4	SiO_2	$Sc_2(CO_3)_3$				R(%)	G(%)	V(%)	Hue	Sats.	Bril.	*L*∗*B*
(A)	Sc_2O_3 Series													
250	PS-0.001	9.9	2.6	0.0153		0.0316	Whitish ivory	36.2	35.6	28.2	575	20.0	82.0	4.407
249	PS-0.010	9.9	2.6	0.1534		0.100	Whitish ivory	37.0	36.1	26.9	575	25.0	80.4	4.388
251	PS-0.100	9.9	2.6	1.5340		0.316	Light yellow, cryst.	38.6	37.4	24.0	575	36.1	75.9	4.328
(B)	TiO_2 Series	Pb_3O_4	SiO_2	TiO_2										
129	PS-0.0025	9.9	2.6	0.0087		0.050	Greenish ivory	37.0	36.2	26.8	581	26	78.0	4.358
130	PS-0.050	9.9	2.6	0.1735		0.224	Greenish yellow	39.1	37.7	23.2	575	39	75.3	4.323
131	PS-0.100	9.9	2.6	0.3470		0.316	P. yel., gray crystals started	37.3	36.2	26.5	577	26.5	72.8	4.288
133	PS-0.500	9.9	2.6	1.7350		0.707	Olive green, separations (R)	38.7	36.9	24.4	576	36	41.3	3.723
(C)	V_2O_5 Series	Pb_3O_4	SiO_2	NH_4VO_3										
100	PS-0.0025	9.9	2.6	0.0204		0.050	V. f. green,	37.5	36.2	26.3	577	28	76.3	4.340
101	PS-0.010	9.9	2.6	0.1013		0.100	Faint green	38.3	37.0	24.7	577	33	74.8	4.316
102	PS-0.025	9.9	2.6	0.2036		0.158	Pale green	39.9	38.3	21.8	577	43.5	71.5	4.266
103	PS-0.100	9.9	2.6	1.0130		0.316	Yellowish green (cryst.)	43.8	40.0	16.2	577	60	63.4	4.150

(1) Oxides of elements forming molecular solutions with glass. The color in this case is thought to be due to the ions. Examples are the elements belonging to the fourth period of the 6th, 7th, and 8th groups in the periodic table.

(2) Elements, oxides, or other compounds distributed within the glass in the form of a dispersed phase. The color in this case is a function of the degree of dispersion of the colored substance. An example of this is ruby glass, but it is to be noted here that the present investigation is primarily interested in the first group. (The second group will be studied in the future.)

R. Zsigmondy[6] stated that the color of a glass depends not only on the nature of the chromatic oxide, but also on the composition of the base glaze as well as the treatment of the glaze. Ramsden[7] stated that the extent to which a glaze can dissolve a chromatic metallic oxide is a measure of the intensity of the color developed and is governed by

(1) Chemical composition of the glaze.
(2) Physical properties of glaze, such as viscosity, etc.
(3) Physical conditions of the chromatic oxide.
(4) Temperature to which the glaze is subjected.
(5) Rate of cooling.

W. Asch and D. Asch,[8] by means of their hexite-pentite theory of silicates, postulated that colored glasses possess a

[6] R. Zsigmondy, *Ann. Physik*, **4**, 60 (1901).

[7] C. E. Ramsden, *Trans. Ceram. Soc.* [Eng.], **5**, 1 (1905–1906).

[8] Asch and Asch, The Silicates in Chemistry and Commerce, D. Van Nostrand Co., 1914 ed., p. 243.

TABLE II

CR, MN, FE GROUP

No.	Composition	Batch Weight			$C^{1/3}$	Description of Color	Trichromatic			Monochromatic			
		Pb_3O_4	SiO_2	$Cr(NO_3)_3 9H_2O$			R(%)	G(%)	V(%)	Hue	Satn.	Bril.	*L*a*b*
(A)	CrO_3 Series												
104	PS-0.0001	9.9	2.6	0.0035	0.010	Light yellow	43.2	40.7	16.1	581	61	70.4	4.254
105	PS-0.0005	9.9	2.6	0.0173	0.022	Yellow	49.5	43.4	7.1	582	84.8	67.1	4.205
106	PS-0.0025	9.9	2.6	0.0865	0.050	Rich orange yellow (C)	55.4	42.1	2.5	583	95	50.0	3.912
107	PS-0.0100	9.9	2.6	0.3465	0.100	Reddish yellow (uneven, C)	63.3	35.6	1.1	590	97.5	21.3	3.060
108	PS-0.1000	9.9	2.6	3.4650	0.316	Big red crystals(play of colors)	71.6	25.4	3.0	604	92.6	10.6	2.361
(B)	MnO_2 Series	Pb_3O_4	SiO_2	$MnSO_4 4H_2O$									
109	PS-0.0025	9.9	2.6	0.0241	0.050	Faint lilac	37.8	34.4	27.8	587	21	52.3	3.960
110	PS-0.005	9.9	2.6	0.0482	0.071	Light lilac	39.0	34.2	26.8	589	25	42.1	3.740
111	PS-0.010	9.9	2.6	0.0964	0.100	Lilac	41.2	32.0	26.8	602	23.6	34.8	3.550
112	PS-0.040	9.9	2.6	0.3856	0.200	Lilac	40.3	32.0	27.7	605	20	21.8	3.082
113	PS-0.160	9.9	2.6	1.5420	0.400	D. red-brown	47.9	28.9	23.2	612	35	5.97	1.787
114	PS-0.250	9.9	2.6	2.4050	0.500	Shiny black	34.6	32.4	23.0	495	2.5	0.92	−0.097
(C)	FeO_3 Series	Pb_3O_4	SiO_2	$Fe(NO_3)_3 9H_2O$									
84	PS-0.001	9.9	2.6	0.0349	0.032	P. whitish green	37.4	36.6	26.0	575	28.5	76.1	4.335
85	PS-0.010	9.9	2.6	0.3490	0.100	P. yellowish green	39.2	38.9	21.9	570	44	71.9	4.277
86	PS-0.025	9.9	2.6	0.8725	0.158	Mottled brownish peach	46.6	37.2	16.2	584	60	49.0	3.894
87	PS-0.050	9.9	2.6	1.7450	0.224	Mottled peach	49.4	37.6	13.0	585	68.5	34.8	3.550
92	PS-0.100	9.9	2.6	3.4900	0.316	Reddish brown	57.1	35.5	7.4	590	83	22.6	3.120
88	PS-0.300	9.9	2.6	10.4700	0.548	Aventurine stack	67.2	31.4	1.4	595	97	8.51	2.141
89	PS-0.400	9.9	2.6	13.9600	0.632	Aventurine (d. red brown)	59.0	28.9	12.1	602	70	3.77	1.328

structure analogous to that of the organic dyestuffs, and that color of the glass is due to the chromophore group and the salt-forming auxochrome group in accordance with the theory which Witt[9] devised for organic dyestuffs. The experimental proof of this postulation, however, is still lacking.

(3) Measurement of Glass and Glaze Colors A review of the literature shows that almost invariably investigators have obtained results by visual observation and recorded color data in indefinite physiological terms such as bright red, dark brown, etc. In view of the fact that color is the complex result of a compound stimulus of the retina consisting of mixtures of radiations of different wave-lengths and intensities; that the human eye is non-uniformly sensitive over the whole spectral range; and that

[9] *Ber. deut. chem. Ges.*, p. 522 (1876).

fatigue and external illuminating conditions influence color perception, observations by eye are naturally inaccurate.

R. Zsigmondy[10] was perhaps the first to measure the color of glasses by determining their extinction coefficient with a spectrophotometer. But he presented his results only in terms of the intensity of the transmitted light, and his data were limited to six elements, *viz.*, Cr, Mn, Fe, Co, Ni, and Cu. It remains to say, therefore, that a more scientific method of determining quantitatively the color of glasses and glazes is necessary and desirable.

III. Color and Its Specification

Ordinarily a substance is regarded as colored, if, under the conditions of observation, it absorbs selectively the rays of the visible spectrum upon reflection from the surface or transmission through the mass. A glaze appears red to the normal eye if the reflected rays contain mainly wave-lengths pertaining to red, the others originally present in the incident ray having been more or less absorbed by the glaze.

[10] *Ann. Physik*, **4** [4], 61 (1901).

TABLE III
Co, Ni, Cu GROUP

No.	Composition	Batch Weight						Description of Color	Trichromatic			Monochromatic		
		Pb_3O_4	SiO_2	$Co(NO_3)_2 6H_2O$	$Ni(NO_3)_2 6H_2O$	$Cu(NO_3)_2 3H_2O$	$C^{1/3}$		R (%)	G (%)	V (%)	Hue	Satn.	Brll.	L*a*b*
(A)	CoO Series														
73	PS-0.025	9.9	2.6	0.3150			0.158	V. light blue	26.1	29.8	44.1	476	10	21.2	3.057
74	PS-0.050	9.9	2.6	0.6300			0.224	Light blue	25.4	29.1	45.5	475	10	20.75	3.035
75	PS-0.100	9.9	2.6	1.2600			0.316	Deep blue	11.8	16.6	71.6	464	24	2.12	0.746
30	PS-0.250	9.9	2.6	3.1500			0.500	V. deep blue	10.2	14.0	75.8	462	23	0.93	−0.073
76	PS-0.500	9.9	2.6	6.3000			0.707	Dark blue	7.6	10.2	82.2	460	26	0.25	
31	PS-1.000	9.9	2.6	12.6000			1.000	Dark bluish black	0.9	3.0	96.1	450	100	0.01	
(B)	NiO Series	Pb_3O_4	SiO_2	$Ni(NO_3)_2 6H_2O$											
115	PS-0.005	9.9	2.6	0.0648			0.0707	L. brownish yellow	40.5	37.8	21.7	577	44	66.9	4.205
116	PS-0.025	9.9	2.6	0.3240			0.1582	Brownish green	44.4	38.3	17.3	582	57	47.3	3.858
117	PS-0.125	9.9	2.6	1.6200			0.3540	Mottled green	47.7	38.4	13.9	583.5	66	28.3	3.343
118	PS-0.250	9.9	2.6	3.2400			0.5000	Green separations	48.4	39.0	12.6	583.5	70	23.3	3.148
119	PS-0.625	9.9	2.6	8.1000			0.7910	Olive green (cryst.)	43.7	38.8	17.5	580	57	25.5	3.240
(C)	CuO Series	PbO_2	SiO_2			$Cu(NO_3)_2 3H_2O$									
204	PS-0.0003	9.9	2.6	0.0031		0.017		Ivory white	36.0	35.5	28.5	575	19	80.0	4.383
200	PS-0.010	9.9	2.6	0.1047		0.100		Ivory green	33.4	36.4	30.2	540	15.6	64.5	4.166
201	PS-0.040	9.9	2.6	0.4188		0.200		Light green	32.1	38.8	29.1	515	25	42.5	3.750
202	PS-0.100	9.9	2.6	1.0470		0.316		Deep green	31.9	41.2	26.9	517	35	25.6	3.243

TABLE IV
Zn, As, Se Group

No.	Composition	Batch Weight			$C^{1/3}$	Description of Color	Trichromatic			Monochromatic			
		Pb_3O_4	SiO_2	ZnO			R(%)	G(%)	V(%)	Hue	Satn.	Bril.	*L*B*
(A)	ZnO Series												
212	PS-0.060	9.9	2.6	0.2095	0.245	Yellowish white	35.2	34.8	30.0	575	13.7	79.4	4.373
256	PS-0.119	9.9	2.6	0.4190	0.345	Yellowish white	36.0	35.2	28.8	576	17.5	80.5	4.388
214	PS-0.595	9.9	2.6	2.1000	0.771	Ivory yellow (cryst.)	36.4	35.6	28.0	576	20.5	80.9	4.392
		Pb_3O_4	SiO_2	As_2O_3									
(B)	As_2O_3 Series												
215	PS-0.05	9.9	2.6	0.499	0.224	Yellowish white	36.2	35.4	28.4	576	20.0	80.7	4.390
216	PS-0.10	9.9	2.6	0.999	0.316	Yellowish white	36.4	35.7	27.9	576	20.5	79.0	4.370
217	PS-0.50	9.9	2.6	4.995	0.707	Yellowish white (cryst.)	36.1	35.4	28.5	576	19.0	76.8	4.342
		Pb_3O_4	SiO_2	SeO_2									
(C)	SeO_2 Series												
134	PS-0.0025	9.9	2.6	0.012	0.050	P. ivory white	35.6	36.4	28.0	568	22	80.3	4.386
135	PS-0.100	9.9	2.6	0.482	0.316	Pale ivory	37.7	36.7	25.6	575	30	78.0	4.358
137	PS-0.500	9.9	2.6	2.409	0.707	Pale ivory	38.1	37.3	24.6	574	34	72.8	4.287

There are two methods for the simple specification of color. In the trichromatic system, the color is specified, independently of brilliance,[11] in terms of a mixture of certain percentages of three hypothetical primary colors, red, green, and violet, chosen in such a way that when the three are combined in exactly equal proportions, white light is produced. In the monochromatic system, the color is specified by means of three independent fundamental psychological attributes, called hue, saturation, and brilliance.

The three attributes of color can be treated as independent quantities and specified numerically. We can conceive of a psychological color solid (see Fig. 1) with hues represented by angular degrees in a normal plane, with reference to a fixed point and axis, and saturation represented by the distance in that

[11] According to the Report of Committee on Colorimetry of the Optical Society of America for 1920–21:

(*a*) Brilliance is that attribute of any color in respect of which it may be classed as equivalent to some member of a series of grays ranging between black and white. Synonyms as used by other writers are luminosity, brightness, tint, value, and visual brightness.

(*b*) Hue is that attribute of certain colors in respect of which they differ characteristically from the gray of the same brilliance and which permits them to be classed as reddish, yellowish, greenish, or bluish.

(*c*) Saturation is that attribute of all colors possessing a hue, which determines their degree of difference from the gray of the same brilliance. Synonyms as used by various other writers are purity and chroma.

See *Jour. Opt. Soc. Amer. & Rev. Sci. Instr.*, **6** [6], 530 (1922).

plane from the fixed point, and brilliance by distance along the axis from the fixed point. These three ordinal values, representing the positions of a given color in the several dimensions of the solid, completely define the color in question.

Applying these definitions, we may therefore say that a pure white has no hue, sautration = 0, and brilliance = 100; a pure black has no hue, saturation = 0, and brilliance = 0; a pure blue-green has hue = 510 mμ, saturation = 100, and brilliance = per cent of the light which would be reflected from a pure white body; a gray has no hue, saturation = 0, and brilliance varying between 0 and 100; and other colors have values of hue varying between 400 and 720 mμ, saturation up to 100, and brilliance always less than 100 and larger than 0.

IV. Plan of Investigation

Lead glazes are known to be brilliant

TABLE V

Yt, Zr, Cb, Mo Group

No.	Composition	Batch Weight					Description of Color	Trichromatic			Monochromatic		
		PbO_2	SiO_2	$Yt_2(CO_3)_3 6H_2O$	$C^1/_3$			R.(%)	G.(%)	V.(%)	Hue	Satn.	Bril.	L=B
(A)	YtO_2 Series													
218	PS-0.001	9.9	2.6	0.0261	0.0316		Whitish yellow	36.0	35.4	28.6	575	21.7	80.0	4.383
219	PS-0.005	9.9	2.6	0.1305	0.0707		Whitish yellow	36.4	35.8	27.8	575	19.7	80.1	4.384
220	PS-0.030	9.9	2.6	0.7830	0.1730		Whitish yellow	35.7	35.2	29.1	575	17.0	83.6	4.425
		PbO_2	SiO_2	$3ZrO_2 \cdot 2N_2O_5$										
(B)	ZrO_2 Series													
152	PS-0.010	9.9	2.6	0.0841	0.1000		White	35.6	35.2	29.2	575	17.0	75.2	4.322
153	PS-0.050	9.9	2.6	0.4205	0.2240		F. bluish white	35.6	35.0	29.4	575	15.0	79.7	4.377
154	PS-0.100	9.9	2.6	0.8410	0.3160		F. bluish white (R, opaque)	34.9	34.6	30.5	580	12.0	85.0	4.443
		PbO_2	SiO_2	Cb_2O_5										
(C)	Cb_2O_5 Series													
221	PS-0.001	9.9	2.6	0.0115	0.0316		White	35.5	35.1	29.4	575	15.0	82.7	4.416
222	PS-0.010	9.9	2.6	0.1150	0.1000		Whitish ivory (yel. sepna.)	35.8	35.4	28.8	575	18.0	80.8	4.391
223	PS-0.040	9.9	2.6	0.4600	0.2000		Yellow separations (uneven)	41.9	38.2	19.9	579	50.0	67.0	4.205
224	PS-0.100	9.9	2.6	1.150	0.3160		Yellow (cryst., R)	42.5	38.0	19.5	580	51.0	65.8	4.185
		PbO_2	SiO_2	$(NH_4)_2MoO_4$										
(D)	MoO_3 Series													
138	PS-0.0025	9.9	2.6	0.021	0.0500		Ivory white	36.5	35.8	27.7	576	27.0	78.5	4.363
139	PS-0.010	9.9	2.6	0.085	0.1000		P. greenish yellow	37.8	36.7	25.5	575	30.0	76.7	4.339
140	PS-0.050	9.9	2.6	0.425	0.2240		P. greenish yellow separations	38.9	37.7	23.4	575	40.0	69.6	4.243
141	PS-0.100	9.9	2.6	0.850	0.3160		Gr. yellow (R, cryst.)	41.4	39.5	19.1	575	52.5	59.3	4.083
142	PS-0.200	9.9	2.6	1.700	0.4470		Yel. orange (M, cryst.)	42.8	39.9	17.3	576	57.0	71.2	4.206

and fusible. On account of the high fluxing power of lead oxide, many oxides combine with it, forming beautiful colors. In the attempt to find the relation between chemical constitution and color, it is desirable to have a base glaze as simple as possible. Therefore a raw lead glaze corresponding to $PbO–SiO_2$ is used throughout this investigation. Various elements calculated as equivalents of oxides are introduced and the resulting glazes are analyzed for color by means of Hardy's recording photoelectric spectrophotometer. The operation of this machine is described in an article by Professor Hardy.[12] Figure 2 is a schematic representation of the recording mechanism reproduced from this article.

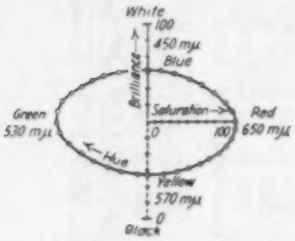

FIG. 1.—Color solid.

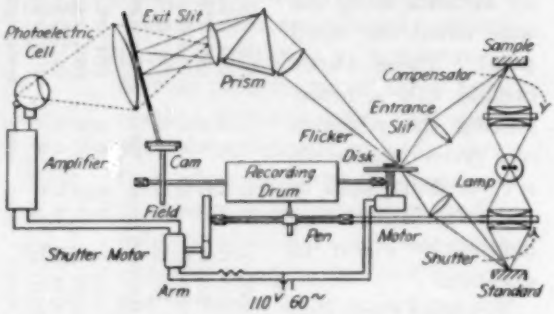

FIG. 2.—The optical system of the color analyzer with a schematic representation of the recording mechanism.

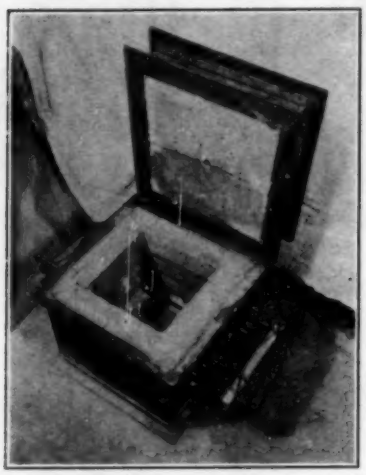

FIG. 3.—Furnace.

The color data obtained are thus absolutely independent of the eye, and contain enough information to identify completely the color of the glazes. For inter-comparison, the spectrophotometric data are then reduced to trichromatic and then monochromatic specifications of color as shown in the following tables. The method of converting the original curve to the monochromatic specifications of color is a rather long

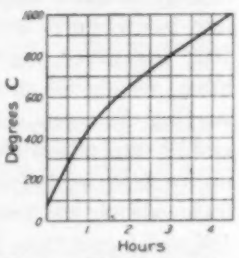

FIG. 4.—Firing schedule.

[12] Arthur C. Hardy, "A Recording Photoelectric Color Analyzer," *Jour. Opt. Soc. Amer. & Rev. Sci. Instr.*, **12** [2], 96 (1928).

TABLE VI

PD, AG, CD GROUP

No.	Composition	Batch Weight			$C^{1/2}$	Description of Color	Trichromatic			Monochromatic			
							R(%)	G(%)	V(%)	Hue	Satn.	Bril.	*LaB*
(A)	PdO Series	Pb_3O_4	SiO_2	$PdCl_2$									
155	PS-0.001	9.9	2.6	0.0077	0.0316	Yellowish ivory	37.0	35.7	27.3	578	23.5	71.9	4.275
156	PS-0 005	9.9	2.6	0.0385	0.0707	Grayish ivory	36.0	35.1	28.9	578	17.4	66.0	4.194
157	PS-0 010	9.9	2.6	0.0770	0.1000	Grayish yellow	36.5	35.7	27.8	577	22	51.3	3.938
158	PS-0 050	9.9	2.6	0.3850	0.2240	Dark gray (dull, R)	35.6	34.5	29.9	580	14	21.6	3.073
(B)	Ag_2O Series	Pb_3O_4	SiO_2	$AgNO_3$									
159	PS-0.0.0	9.9	2.6	0.1472	0.100	F. greenish ivory C	37.1	36.3	26.6	574	27	72.7	4.286
160	PS-0.060	9.9	2.6	0.8832	0.245	Greenish ivory, C	35.3	35.5	29.2	572	17	73.0	4.292
161	PS-0.100	9.9	2.6	1.4720	0.316	Light green	34.7	35.7	29.6	565	15.5	66.6	4.200
162	PS-0.300	9.9	2.6	4.4160	0.548	Light green (gray sepns.)	35.9	35.9	28.2	575	12	63.2	4.147
163	PS-0.500	9.9	2.6	7.3600	0.707	P. green (Ag separations)	37.4	37.4	25.2	572	32.3	60.6	4.103
(C)	CdO Series	Pb_3O_4	SiO_2	$Cd(NO_3)_2{\cdot}4H_2O$									
124	PS-0.010	9.9	2.6	0.134	0.100	Ivory	37.8	36.7	25.5	578	30	74.0	4.302
125	PS-0.025	9.9	2.6	0.334	0.158	Ivory	36.7	36.0	27.3	576.5	24	72.1	4.278
126	PS-0.100	9.9	2.6	1.340	0.316	P. whitish yellow	36.7	36.0	27.3	576.5	22	69.0	4.235
127	PS-0.250	9.9	2.6	3.340	0.500	Whitish yellow	36.5	35.8	27.7	575	22	78.1	4.360
128	PS-0.500	9.9	2.6	6.680	0.707	Pale yellow	37.6	36.6	25.8	574	29.5	80.1	4.383

TABLE VII

SN, SB, TE GROUP

No.	Composition	Batch Weight			$C^{1/2}$	Description of Color	Trichromatic			Monochromatic			
							R(%)	G(%)	V(%)	Hue	Satn.	Bril.	*LaB*
(A)	SnO_2 Series	Pb_3O_4	SiO_2	SnO_2									
225	PS-0.05	9.9	2.6	0.327	0.224	Ivory white	36.4	35.9	27.7	574	22.4	81.0	4.394
226	PS-0.10	9.9	2.6	0.654	0.316	Ivory white (minute bubbles)	36.2	35.4	28.4	577	20	79.7	4.377
227	PS-0.50	9.9	2.6	3.270	0.707	White (mat)	35.6	34.8	29.6	579	15	75.0	4.317
(B)	Sb_2O_3 Series	Pb_3O_4	SiO_2	Sb_2O_3									
121	PS-0.001	9.9	2.6	0.0126	0.0316	Yellowish white C	37.4	36.6	26.0	580	28	78.1	4.360
122	PS-0.010	9.9	2.6	0.1260	0.1000	Yellow C	45.9	41.0	13.1	578	69	70.5	4.255
257	PS-0.020	9.9	2.6	0.252	0.1414	Mottled yellow	46.3	39.2	14.5	582	65	65.0	4.173
123	PS-0.100	9.9	2.6	1.261	0.3160	Deep yellow	52.8	39.9	7.3	583	83	52.2	3.954
(C)	TeO_2 Series	Pb_3O_4	SiO_2	TeO_2									
164	PS-0.01	9.9	2.6	0.069	0.100	White	35.2	34.8	30.0	577	13.7	81.3	4.399
165	PS-0.10	9.9	2.6	0.690	0.316	White	34.9	34.5	30.6	577	12.0	81.0	4.394
166	PS-0.20	9.9	2.6	1.380	0.448	White	34.8	34.4	30.8	578	10.0	81.5	4.403

TABLE VIII

RARE EARTHS GROUP

No.	Composition	Batch Weight			C.I.E.	Description of Color	Trichromatic			Monochromatic			
(A)	Ce_2O_3 Series	Pb_3O_4	SiO_2	$Ce_2(C_2O_4)_3 9H_2O$			R(%)	(G%)	V(%)	Hue	Satn.	Bril.	*LaB*
228	PS-0.001	9.9	2.6	0.0306	0.0316	Yellowish ivory	36.8	36.1	27.1	575	25	81.3	4.398
229	PS-0.010	9.9	2.6	0.3060	0.1000	Light yellow	38.6	37.6	23.8	574	37	78.3	4.362
230	PS-0.040	9.9	2.6	1.2240	0.2000	Mottle peach	43.8	36.8	19.4	584	50	49.4	3.900
231	PS-0.100	9.9	2.6	3.0600	0.3160	Peach brown (cryst.)	44.6	35.0	20.4	588	47	36.6	3.600
(B)	Pr_2O_3 Series	Pb_3O_4	SiO_2	$Pr_2(SO_4)_3$									
232	PS-0.002	9.9	2.6	0.0494	0.0447	Ivory white	35.8	35.2	29.0	576	17.3	82.0	4.407
233	PS-0.010	9.9	2.6	0.2470	0.1000	Ivory white	35.8	35.4	28.8	575	17.6	83.6	4.425
234	PS-0.100	9.9	2.6	2.4700	0.3160	Ivory green	37.8	37.2	25.0	573	32.5	79.0	4.370
(C)	Nd_2O_3 Series	Pb_3O_4	SiO_2	$Nd_2(C_2O_4)_3 9H_2O$									
235	PS-0.001	9.9	2.6	0.0309	0.0316	White	33.6	35.2	31.2	543	10	77.8	4.353
236	PS-0.010	9.9	2.6	0.3090	0.1000	White	35.1	34.8	30.1	575	13.4	74.7	4.313
237	PS-0.040	9.9	2.6	1.2360	0.2000	P. pink	36.7	35.0	28.3	577	20	42.0	3.738
238	PS-0.080	9.9	2.6	2.4720	0.2830	Pink separations on white	36.4	35.8	27.8	581	22	40.0	3.690
(D)	Di_2O_3 Series	Pb_3O_4	SiO_2	$Di_2(C_2O_4)_3 9H_2O$									
239	PS-0.002	9.9	2.6	0.624	0.0447	White	35.5	35.1	29.4	576	15	82.3	4.411
240	PS-0.010	9.9	2.6	0.3115	0.1000	White	36.0	35.4	28.6	575	19	78.1	4.358
241	PS-0.050	9.9	2.6	1.557	0.2240	White	35.5	35.2	29.4	575	15	75.7	4.325
242	PS-0.100	9.9	2.6	3.115	0.3160	White	35.6	34.8	29.6	576	15	72.7	4.285
(E)	Sm_2O_3 Series	Pb_3O_4	SiO_2	$Sm_2(C_2O_4)_3 9H_2O$									
243	PS-0.001	9.9	2.6	0.0314	0.0316	White	35.9	35.5	28.6	575	19	82.5	4.412
244	PS-0.010	9.9	2.6	0.3140	0.1000	White	36.0	35.4	28.6	575	19	79.8	4.378
245	PS-0.080	9.9	2.6	3.142	0.2830	Light yellow (cryst.)	38.0	37.0	25.0	575	32.4	79.1	4.371

TABLE IX
TA, W, PT GROUP

No.	Composition	Batch Weight			$C^{1/3}$	Description of Color	Trichromatic			Monochromatic			
		Pb_3O_4	SiO_2				R(%)	G(%)	V(%)	Hue	Satn.	Bril.	*LaB*
(A)	Ta_2O_5 Series	Pb_3O_4	SiO_2	Ta_2O_5									
167	PS-0.001	9.9	2.6	0.0192	0.0316	White	35.4	35.0	29.6	576	15	80.5	4.386
168	PS-0.010	9.9	2.6	0.1919	0.1000	White	35.4	35.0	29.6	576	15	80.8	4.389
168.5	PS-0.040	9.9	2.6	0.7676	0.200	Ivory white	38.3	37.0	24.7	576	34	80.2	4.383
169	PS-0.100	9.9	2.6	1.9190	0.316	Yellowish ivory	39.0	38.0	23.0	575	40	81.4	4.401
(B)	WO_3 Series	Pb_3O_4	SiO_2	H_2WO_4									
143	PS-0.0025	9.9	2.6	0.0270	0.050	P. grayish ivory	37.3	36.3	26.4	575	27.5	76.6	4.338
144	PS-0.050	9.9	2.6	0.5408	0.224	P. yel. green (cryst.)	39.7	38.1	22.2	575	42.5	72.4	4.283
145	PS-0.100	9.9	2.6	1.0816	0.316	Yellow (beautiful crystals)	41.9	39.5	18.6	576	54.5	71.5	4.271
146	PS-0.200	9.9	2.6	2.1630	0.447	Yellow (M, cryst.)	42.9	40.2	16.9	576	59.0	75.7	4.327
(C)	PtO Series	Pb_3O_4	SiO_2	$PtCl_4 \cdot 2HCl \cdot 6H_2O$									
170	PS-0.002	9.9	2.6	0.0448	0.0448	Light uneven gray	35.6	34.5	29.9	581	14	45.0	3.808
171	PS-0.010	9.9	2.6	0.2241	0.1000	Uneven gray	36.3	35.3	28.4	579	19	22.6	3.118
172	PS-0.030	9.9	2.6	0.6723	0.173	Dark uneven gray	36.7	34.5	28.8	582	19	10.28	2.331

TABLE X
AU, HG, TL GROUP

No.	Composition	Batch Weight			$C^{1/3}$	Description of Color	Trichromatic			Monochromatic			
		Pb_3O_4	SiO_2	$AuCl_3 \cdot HCl \cdot 3H_2O$			R(%)	G(%)	V(%)	Hue	Satn.	Bril.	*LaB*
(A)	Au_2O Series	Pb_3O_4	SiO_2										
173	PS-0.001	9.9	2.6	0.0341	0.0316	Light red-violet	36.5	33.8	29.7	590	14	58.1	4.063
174	PS-0.010	9.9	2.6	0.3414	0.100	Reddish violet	39.0	33.0	28.0	596	20	35.4	3.566
175	PS-0.0415	9.9	2.6	1.4070	0.202	Deep reddish violet	41.6	32.2	26.2	600	25.5	23.2	3.144
(B)	HgO Series	Pb_3O_4	SiO_2	$Hg(NO_3)_2$									
176	PS-0.010	9.9	2.6	0.1408	0.100	Ivory white	35.9	35.3	28.8	577	18	80.1	4.384
177	PS-0.100	9.9	2.6	1.4080	0.316	F. sky blue	34.1	35.0	30.9	562	10	70.5	4.256
178	PS-0.300	9.9	2.6	4.2240	0.548	Light sky blue	34.0	35.2	30.8	560	10.5	75.9	4.329
179	PS-0.500	9.9	2.6	7.0400	0.707	Sky blue	34.8	34.9	30.3	574	10	79.7	4.378
(C)	Tl_2O_3 Series	Pb_3O_4	SiO_2	$TlNO_3$									
180	PS-0.010	9.9	2.6	0.2305	0.100	White	35.1	34.8	30.1	575	13.5	78.5	4.363
181	PS-0.050	9.9	2.6	1.1525	0.224	Ivory	34.9	34.6	30.5	575	12.0	74.6	4.312
182	PS-0.100	9.9	2.6	2.3050	0.316	F. ivory gray (spotted)	35.8	35.4	28.8	575	18.0	79.2	4.372

TABLE XI

Bi, Th, U GROUP

No.	Composition	Batch Weight			$C^{1/3}$	Description of Color	Trichromatic			Monochromatic			$L*B$
		Pb_3O_4	SiO_2	$BiO(NO_3)H_2O$			R(%)	G(%)	V(%)	Hue	Satu.	Bril.	
(A)	Bi_2O_3 Series												
183	PS-0.001	9.9	2.6	0.0264	0.0316	Ivory white	35.7	35.2	29.1	576	17	82.0	4.405
184	PS-0.010	9.9	2.6	0.2640	0.100	Ivory white	36.1	35.6	28.3	576	20	78.0	4.357
185	PS-0.100	9.9	2.6	2.6400	0.316	Ivory	36.8	36.0	27.2	576	25	77.6	4.355
186	PS-0.300	9.9	2.6	7.9200	0.548	Ivory yellow	38.2	37.0	24.8	576	33.5	73.0	4.292
187	PS-0.500	9.9	2.6	13.2050	0.707	Pale yellow	38.5	37.3	24.2	576	35	70.1	4.252
(B)	ThO_2 Series	Pb_3O_4	SiO_2	$Th(NO_3)_4 12H_2O$									
246	PS-0.001	9.9	2.6	0.0302	0.0316	Yellowish ivory	36.6	36.0	27.4	574	23.7	79.7	4.377
247	PS-0.010	9.9	2.6	0.3020	0.100	Yellowish ivory	37.0	36.3	26.7	574	27.0	77.7	4.352
248	PS-0.100	9.9	2.6	3.0200	0.316	Yellowish ivory (cryst.)	36.5	35.7	27.8	575	22.2	77.1	4.345
(C)	UO_3 Series	Pb_3O_4	SiO_2	$UO_2(NO_3)_6H_2O$									
95	PS-0.0025	9.9	2.6	0.0543	0.050	P. brownish yellow	36.6	35.9	27.5	575	23	79.0	4.369
96	PS-0.010	9.9	2.6	0.2175	0.100	Light peach yellow	45.3	38.8	15.9	582	61	61.9	4.124
97	PS-0.025	9.9	2.6	0.5436	0.158	Peach yellow	47.9	39.1	13.0	583	69	58.3	4.065
98	PS-0.050	9.9	2.6	1.0870	0.224	Peach	53.4	38.8	7.8	585	32	50.0	3.912
99	PS-0.100	9.9	2.6	2.1750	0.316	Deep orange yellow	55.9	38.0	6.1	587	86	46.4	3.836
149	PS-0.200	9.9	2.6	4.348	0.447	Orange	56.1	37.8	6.1	587	86	33.9	3.524
150	PS-0.400	9.9	2.6	8.696	0.632	Reddish orange	57.7	36.8	5.5	588	87.5	31.9	3.463
151	PS-0.600	9.9	2.6	13.044	0.775	Dark orange	54.4	37.7	7.9	587	82	25.5	3.238

and involved process, and will not be discussed here. The reader should consult the references below for details of the method.[13]

Chemically pure red lead and flint were used for making up the base glaze. Chemically pure soluble salts of the coloring elements were used in all but a few cases as they gave a much more even distribution of color than the oxides. Frits were not used because of the danger of volatilization and contamination. The technique of using soluble salts was developed to give satisfactory results, a uniformly colored glaze free from specks being obtained in all cases.

After the glaze ingredients were weighed out and placed in a beaker, dextrine solution and water were then added, and the consistency adjusted until the per-

[13] (*a*) Colorimetry Report (footnote 11, p. 42).

(*b*) H. E. Ives, "The Transformation of Color Mixture Equations from One System to Another," *Jour. Franklin Inst.*, **195**, 43 (1923).

(*c*) H. D. Bruce, "Tinting Strength of Pigments," Bur. Stand., *Jour. Research* [Paper No. 7], August, p. 147 (1928).

centage of solids was 50% by weight of the total. The solution was thoroughly mixed and immediately sprayed on to a warm tile. The glaze dried instantly on striking the surface and built up into an even and homogeneous layer quite representative of the liquid glaze. Of course constant stirring was required during the spraying process to prevent the lead oxide from settling out. The body used was a biscuited white wall tile $2^1/_8$ inches square. The tile was supported on the arm of a balance weighing to an accuracy of 0.05 gram, and 3.0 grams were sprayed on to each tile.

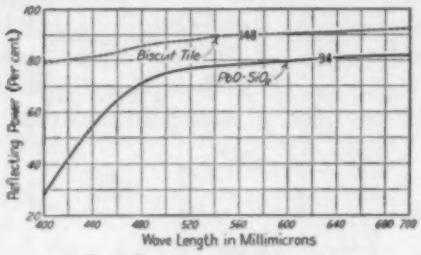

FIG. 5.—Base glaze group.

All samples were given the same treatment and fired in an oxidizing atmosphere to 1000°C in four and one-half hours in a specially built electric furnace with silicon-carbide resistors (see Fig. 3). Cooling took place gradually over a period of twelve hours. Figure 4 shows a typical firing schedule of the glazes.

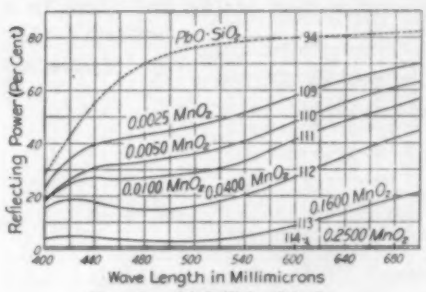

FIG. 6.—$PbO{\cdot}SiO_2{\cdot}cMnO_2$.

For some elements, different amounts of glazes were used to study the effect of weight of application and thickness of glaze layer on color. Different salts of the same elements were also tried in some cases to see if these had any effect on the color development of a given element.

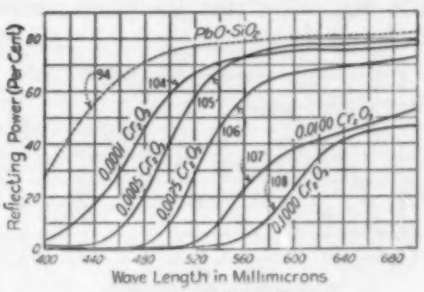

FIG. 7.—$PbO{\cdot}SiO_2{\cdot}cCr_2O_3$.

V. Results

Results were obtained with glazes containing varying amounts of the following elements: Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Yt, Zr, Cb, Mo, Pd, Ag, Cd, Sn, Te, Ce, Pr, Nd, Sm, Ta, W, Pt, Au, Hg, Tl, Bi, Th, and U. Over 250 tile were glazed and the resulting colors analyzed. Figure 5 contains the spectro-reflecting data, corrected for $MgCO_3$, of the unglazed tile, numbered 148, and the base glaze PbO–SiO_2, numbered 94. Figures 6, 7, 8, 9, and 10 are a few representative examples, containing families

of curves for PbO–SiO_2 glazes, with various equivalent concentrations of Cr_2O_3, MnO_2, Fe_2O_3, NiO, and CuO, respectively. There is, of course, insufficient space to give all of these curves.

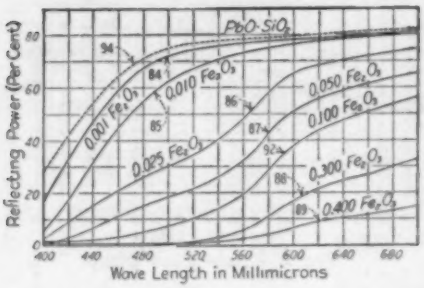

FIG. 8.—$PbO{\cdot}SiO_2{\cdot}cFe_2O_3$.

By varying the weight of application of a given glaze material, different thicknesses of glaze layer were obtained. Figure 11 is an example showing the reflecting data of a glaze having a composition of PbO–$2SiO_2$–0.25CuO, but weight of application varying from 0.5 to 5.0 grams per sample. The thickness of the matured glaze was measured by means of a microscope equipped with a calibrated eyepiece micrometer, after lapping down the cross-section of tile and glaze to a smooth surface by successively decreasing the size of abrasives.

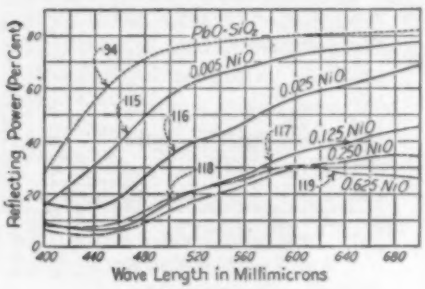

Fig. 9.—$PbO{\cdot}SiO_2{\cdot}c$NiO.

Chemical analyses of some of the glazes were made to check the calculated compositions with the actual composition. The samples were prepared by grinding off the tile until only a very thin transparent layer of the glaze was left, of the thickness of about 0.10 mm. This was then reduced to powder and analyzed in the usual manner. It was found that the silica content has invariably been increased, and that lead and chromatic oxides were slightly lower than the calculated values. But the ratio between the latter two remained close to that in the original mixture. A typical analysis is given as

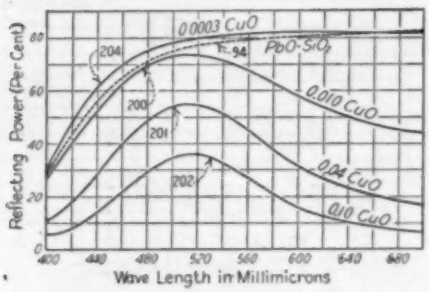

Fig. 10.—$PbO{\cdot}SiO_2{\cdot}c$CuO.

	(%)
PbO	63.40
MnO_2	4.11
SiO_2	32.50

This corresponds to 1 PbO–1.92 SiO_2–0.167 MnO_2. The original mixture contained 1 PbO–1.00 SiO_2–0.160 MnO_2.

This shows that about one equivalent of silica was picked up from the

tile or that some of the lead was volatilized. The shortness of the firing, however, should preclude much change from the latter cause.

In the following tables are given the characteristics of all the glazes made up, including the composition, batch weights, description of color, and trichromatic and monochromatic specifications of color. Unless otherwise noted, the glazes were perfectly smooth and glossy.

(1) Abbreviations The following abbreviations will be used in the tables:

PS	= PbO–SiO_2	R	= rough
R	= red	v	= very
G	= green	f	= faint
V	= violet	l	= light
C	= equivalent concentration of the chromatic oxide	d	= dark
		c	= crazed
Cryst.	= crystallized	M	= mat

VI. Interpretation of Results

(1) Variation of Hue After converting the spectral reflecting data to monochromatic specifications of color, it was found that the variation of hue with respect to change of concentration in the case of all the elements studied is represented by the equation

$$H = H_1 - (\log C_1 - \log C)K_H$$

Where H = hue in millimicrons
H_1 = hue of colored glaze corresponding to concentration C_1, *i.e.*, containing one equivalent of the chromatic oxide. This value was extrapolated from the hue curves
C = concentration of the chromatic oxide in equivalents
$K_H = \frac{\Delta H}{\Delta \log C}$ = reciprocal of the slope of hue curves

Figure 12 shows the relation between hue and logarithm of concentration of the chromatic oxides. Many do not undergo any change in hue with change in concentration. These are not included in this graph. It is found that elements with hue at 0.10 equivalent concentration greater than 578 mμ have positive K_H, *i.e.*, the hue shifts toward the red end of the spectrum with increase in concentration, and those with hue smaller than 575 mμ, negative K_H, *i.e.*, hue shifts toward the violet end of the spectrum. Between the region 575 and 578 mμ, the hue remains constant for a large number of elements. This is explained by the fact that since the base glaze has a hue of 575, the addition of any element, which gives a hue identical with that of the base glaze or

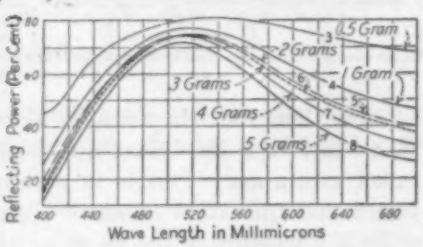

FIG. 11.—PbO·$2SiO_2$·0.025CuO.

which does not give any hue at all, will not affect the dominant wavelength of the resulting glaze, that is to say, $K_H = 0$.

(2) Variation of Color Saturation The variation of color saturation with concentration for all elements studied is represented by the equation

$$S = S_1 - (\log C_1 - \log C)K_S$$

Where S = saturation, the second attribute of color
S_1 = saturation of colored glaze corresponding to concentration C_1, *i.e.*, containing one equivalent of the chromatic oxide. The value was extrapolated from the saturation curves
$K_S = \frac{\Delta S}{\Delta \log C}$ = reciprocal of the slope of saturation curve

Figure 13 shows the relation between saturation and logarithm of concentration of the oxides. The color results together with crystallization data

TABLE XII

PERIODIC ARRANGMENT OF ELEMENTS

	I	II	III	IV	V	VI	VII	VIII		
1	H 1							2 He		
2	Li 3	4 Be	B 5	6 C	7 N	8 O	9 F	10 Ne		
3	Na 11	12 Mg	Al 13	14 Si	15 P	16 S	17 Cl	18 A		
4	K 19	Ca 20	Sc 21 Colorless	Ti 22 Greenish Yellow	V 23 Yellowish Green	Cr 24 Deep Yellow	Mn 25 Lilac		26 Fe Reddish Brown	27 Co Dark Blue	28 Ni Olive Green
	29 Cu Green	30 Zn White	31 Ga	32 Ge	33 As White	34 Se Colorless	35 Br	36 Kr			
5	Rb 37	Sr 38	Yt 39 Colorless	Zr 40 White	Cb 41 Yellow	Mo 42 Greenish Yellow	43		44 Ru	45 Rh	46 Pd Grey
	47 Ag Light Green	48 Cd Pale Yellow	49 In	50 Sn White	51 Sb Yellow	52 Te White	53 I	54 Xe			
6	Cs 55	Ba 56	57-71 Rare Earths	Hf 72	Ta 73 White	W 74 Yellow	75		76 Os	77 Ir	78 Pt Grey
	79 Au Reddish Violet	80 Hg Sky Blue	81 Tl Colorless	82 Pb	83 Bi Ivory Yellow	84 Po	85	86 Nt			
7		Ra 88	Ac 89	Th 90 Colorless	Ux 91	U 92 Orange					

The elements enclosed with heavy lines have been tested

seem to show that the ability with which a chromatic oxide can be dissolved in a clear base glaze is a rough measure of that attribute of color called saturation. This is in agreement with Ramsden's[14] results who stated that the extent to which a glaze can dissolve a chromatic metallic oxide is a measure of the intensity of the color developed, if we mean by intensity, saturation. V, Cb, Ta, Cr, Mo, and U have high saturation values. Ag, Au, Co, Pd, Pt, Zn, Cd, Hg, and Yt have low saturation values. The former group is more or less amphoteric, and the latter more

[14] See footnote 7, p. 39.

positive than negative. Te, which is more negative than positive, also has very low saturation values. In view of these facts, Watson's[15] statement in regard to the color of inorganic compounds that neither the strongly positive nor the strongly negative elements show much color development

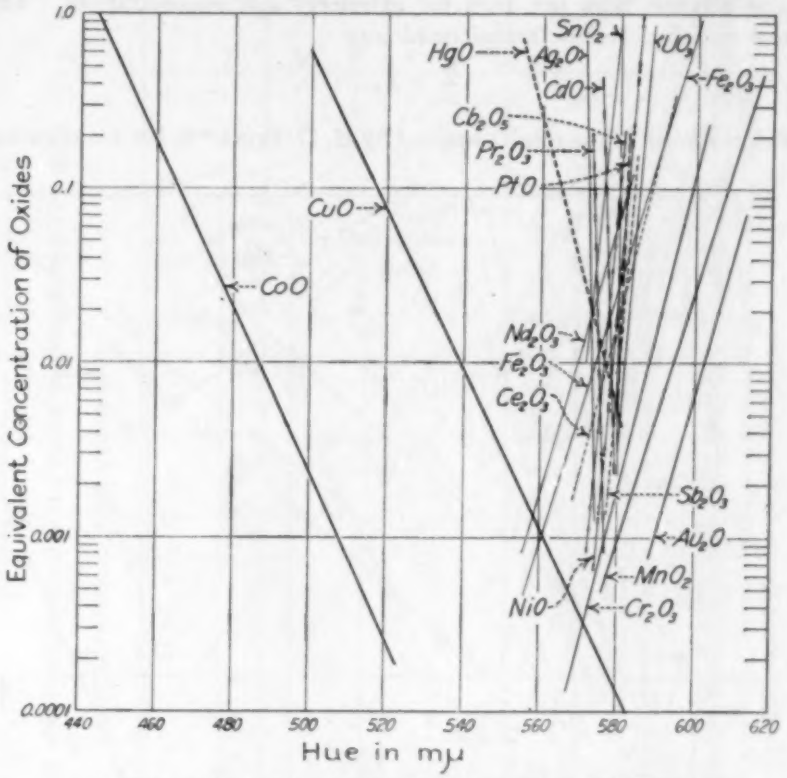

FIG. 12.—Hue vs. log concentration. Base glaze: $PbO–SiO_2$.

is partially applicable to glazes, looking from the point of view of saturation.

(3) Variation of Brilliance

The variation of the third attribute of color, brilliance, with respect to concentration, can be expressed by the equation:

$$LnB = LnB_0 + C^{1/2} LnK_B$$

Where B = brilliance
B_0 = brilliance of colored glaze at zero concentration of the chromatic oxide. This value was obtained by extrapolation from the brilliance curves.
$Ln\,K_B = \frac{\Delta\, Ln\, B}{\Delta C^{1/2}}$ = slope of brilliance curve

[15] See footnote 4, p. 38.

Figure 14 shows the relation between the natural logarithm of brilliance and the square root of concentration of the chromatic oxides. The fact that all these lines do not converge to a point at zero concentration, corresponding to the brilliance of the base glaze, is probably because the empirical relation does not hold for extremely low concentrations. The above equation can be transformed into

$$\frac{B}{B_0} = K_B C^{1/3}$$

which is similar to the result obtained by H. D. Bruce[16] in his investigation

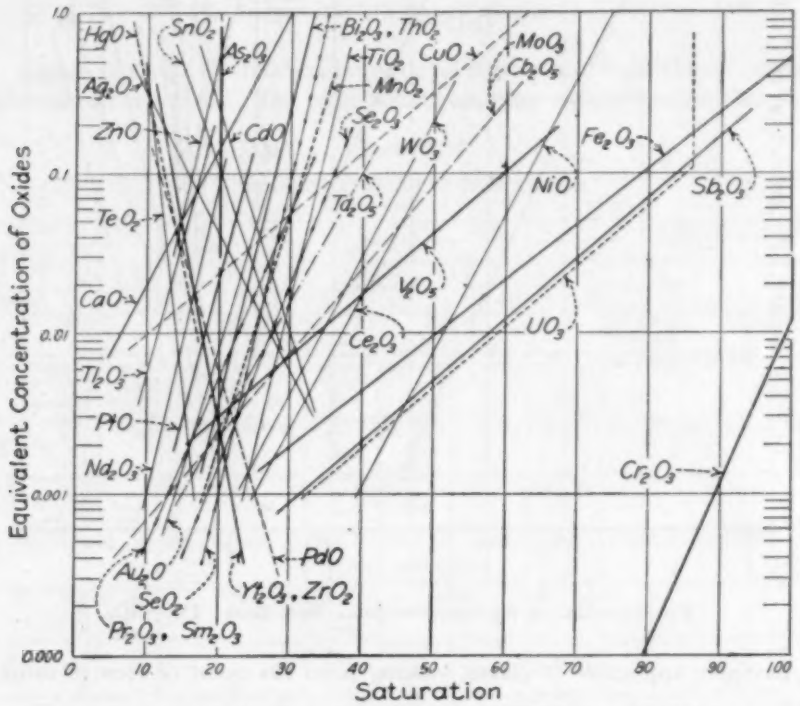

FIG. 13.—Saturation *vs.* log concentration. Base glaze: $PbO\text{-}SiO_2$.

of pigments. He gave an empirical relation between the brilliance of a tint and the concentration of the pigment as

$$\frac{B_t - B_p}{B_w - B_p} = \alpha - C^{1/3}$$

where B_t represents the brilliance of any tint made by mixing C parts by weight of a test pigment of brilliance, B_p, with 10,000 parts of a stand-

[16] See footnote 13 (*c*), p. 48.

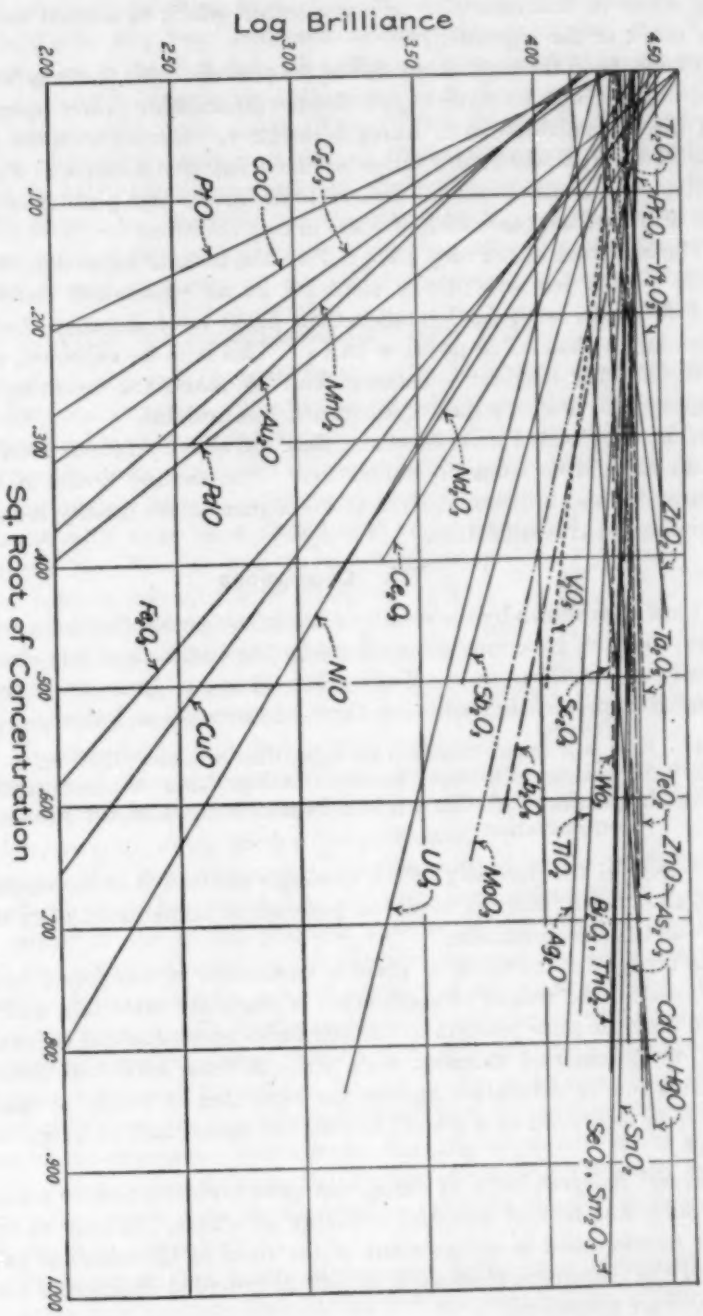

Fig. 14.—Log brilliance vs. square root of concentration. Base glaze: $PbO \cdot SiO_2$.

ard white of brilliance B_w. α is a constant which he termed the darkening index of the pigment.

Elements on the right hand side of the periodic table, such as Ni, Pd, Pt, Co, Fe, Mn, and Cr have high brilliance diminishing power upon increasing the concentration, *i.e.*, LnK_B is negative. Elements on the left hand side of the periodic table, with the exception of Au and Cu, have small brilliance decreasing power, and in some cases, LnK_B is even positive, *i.e.*, brilliance increases with increase in concentration.

The brilliance of the base glaze is 77.5, the natural logarithm of which is 4.350. With few exceptions, elements at an equivalent concentration of 0.10 oxide, with LnB smaller than 4.350 have negative LnK_B, and those larger than 4.350 positive LnK_B. This is to be expected, since the additions of a brighter substance tend to make the resulting mixture brighter, and that of a darker substance, less brilliant.

It must be stated here, however, that the above relations hold only for glazes fairly free from crystallization. The sudden break in the hue, saturation, and brilliance curves at the higher values usually indicates the beginning of crystallization.

VII. Conclusions

It has been shown by the results of this investigation that for a given base glaze, the laws governing color effects by the additions of any element are exactly applicable to those of any other element. In terms of the monochromatic specifications of color, these relations are as follows:

(1) Hue is a linear function of logarithm of concentration.
(2) Saturation is a linear function of logarithm of concentration.
(3) Logarithm of brilliance is a linear function of the square root of concentration.

In view of the diversity of the elements studied, it is surprising to see that all of them, whether negative, positive, or amphoteric, obey the same rules as to color formation.

As far as the thickness of glaze is concerned, it was found to be proportional to the weight of application of the glaze materials, and both of them bore the same relation to the attributes of color as did the concentration of the coloring element, since straight lines were also obtained by plotting hue or saturation against the logarithm of weight of application as well as logarithm of brilliance against the square root of weight of application.

Several different salts of chromium gave consistent color results, and the same was true of iron and probably all others. It may be said that color development is independent of the form of the colorless radical to which the chromatic element is attached, provided chemically pure substances are employed.

The color effects of the elements and their atomic and periodic properties as shown in Table XII have not been satisfactorily correlated as yet. This is due in part to the fact that color effects as observed by the eye are the results of selective absorption of the visible part of the spectrum only, ranging in wave-length from about 400 to 700 millimicrons. Selective absorption of equal importance may occur in the invisible part of the spectrum, especially in the ultra-violet regions. Only through a comprehensive study of the absorption bands of the elements over the entire spectrum, both visible and invisible, can we hope to derive a complete relationship between the atomic structure of the elements and their color effects.

VIII. Recommendation for Future Work

Only the effects of single elements on the color formation of glazes are studied in this investigation. Production of colors by using more than one chromatic oxide is very common. The prediction of what chromatic results will occur when two or more elements are mixed in given proportions in a glaze is very useful and interesting.

Experiments with dyes have shown that the color of a mixture of two dyes at any given concentration on the same basis of solvent can be predicted from the individual color curves of the two dyes.

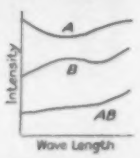

FIG. 15.—Intensity distribution of mixed dyes.

In Fig. 15, let A and B be the spectral intensity distribution curves for dyes A and B. Then the intensity of the mixture AB at any particular wave-length will be that of A multiplied by that of B at the corresponding wave-length. Since the maximum intensity is unity, it is natural that the intensity distribution curve of any mixture will always be lower than that of either one from which the mixture is derived.

It is thought that similar reasoning can be applied in the prediction of color mixtures of glazes, provided no abnormal interactions occur. The reflective power of the mixed glaze at any wave-length would be the product of the reflective power of the mother glazes at the same wave-length, and since the maximum reflective power of any glaze is 100%, the brilliance of the mixture will always be lower, *i.e.*, the color darker than that of either of the mother glazes. Experiments with PbO–SiO_2 glazes containing various mixtures of Cr and Cu, Co and Fe, Cu and Co, and Cr and Co, have invariably resulted in producing colors much darker than those obtained with single elements. But it seems that the use of raw glazes and soluble salts does not give uniform distribution of colors in this case, and hence these mixed glazes were not analyzed for color, for fear that erroneous conclusion might be arrived at.

It is hoped, however, that future workers can devise some technique of producing absolutely uniform distribution of color upon mixing different

elements in a glaze. One possible way would be fritting of the glazes, with elimination, however, of contamination and volatilization. Another method would be to study the color mixtures of glasses by means of the transmission curves, instead of the glazes, since uniform distribution can be much more easily obtained in the former than in the latter. Actual color data of the mixture can then be compared with those calculated theoretically by combining the individual color curves of the mother glazes when reduced to the same basis, and equations can then be set up representing the course of change of the three attributes of color upon mixing of various elements or oxides in various proportions.

Other work of this same nature will include color studies of the elements with other base glazes and also colors developed under reducing conditions. Colors derived from colloids in glazes or glasses would also be an interesting field for research.

Acknowledgment The writer wishes to thank Frederick H. Norton and Arthur C. Hardy for their interest and help in this investigation.

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NOTE ON THE TRANSVERSE STRENGTH OF GLASS[1]

By C. H. Greene

In a paper entitled "The Physical Properties of the Glasses and Their Relation to the Composition," by G. Gehlhoff and M. Thomas,[2] it was noted that the authors give the following formula for the transverse strength of an elliptical rod:[3]

$$F_b = \frac{Pl}{a^2 b \pi}$$

F_b = transverse strength
P = weight of load
l = distance between knife edges
a = small axis of rod
b = large axis of rod

The rod was placed so that the larger axis was horizontal when the load was applied. They also state that for the rods which they used with a diameter of from 3 to 5 millimeters, a standard value for a^2b of 40 mm.[3] (carelessly translated 40 sq. mm.) was convenient for interpolation. This indicates that the values which they substituted in the above formula were the full major and minor axes of the ellipse of cross-section of the rod. For such the formula is not correct.

In the formula, a and b should denote the semi-axes, comparable to the radius of a circular rod, and if they are to be the full axes, comparable to the diameter, the formula should read as follows:

$$F_b = \frac{8\,Pl}{a^2 b \pi}$$

where the other quantities have the same significance as before. In consequence of this mistake all of the values for transverse strength subsequently given in the paper should be multiplied by 8.

Thus for the annealed rod of lead glass the strength should be 9.84 kg. per mm.^{2} instead of 1.23 kg. per mm.^{2} The highest strength obtained as judged from the graphs accompanying the paper was 2.6 kg. per mm.,^{2} which should have been 20.8 kg. per mm.^{2} As a rule, tensile strengths measured by a transverse test run somewhat higher than when measured by a direct pull test. In view of the fact that Gehlhoff and Thomas found values ranging from 4 to 8 kg. per mm.^{2} for the tensile strengths of the same glasses in a direct pull test, the above corrected values seem more probable than the low values reported for the transverse strength by them.

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[1] Received September 8, 1931.

[2] G. Gehlhoff and M. Thomas, *Z. tech. Physik*, **7**, 105–26 (1926); English translation, *Glass Ind.*, **10** [4], 83 (1929).

[3] *Z. tech. Physik*, **7**, 113 (1926); translation, *Glass Ind.*, **10** [5], 113 (1929).

Many tests made in this laboratory upon rods of the same size as those used by Gehlhoff and Thomas and by a similar method indicate that strengths ranging from 10 to 20 kg. per mm.^{2} are usual for samples of this size. The higher corrected values also seem to agree better with the data recorded in the literature although no data which are directly comparable have been discovered.

Winklemann and Schott[4] obtained values ranging from 3.80 to 9.19 kg. per mm.^{2} by a direct pull test. Littleton[5] found a value of 7.6 kg. per mm.^{2} by a transverse test on specimens of square cross-section 5 mm. on a side. This was for a lead glass which had been annealed. Littleton and Preston[6] indicate by a graph a strength of 5.7 kg. per mm.^{2} for unstrained glass. This was also a transverse test, the cross-section being rectangular 0.75 by 0.272 inch. O. Graf[7] obtained strengths from 5 to 6 kg. per mm.^{2} by bending rather long strips with a cross-section 100 mm. by 5 or 6 mm. In view of the tendency toward lower strengths with increased cross-section noted by Gehlhoff and Thomas and also in experiments in this laboratory, these latter results would agree better with strengths of 10 to 20 kg. per mm.^{2} than with the lower values reported by Gehlhoff and Thomas. Brodmann[8] using specimens of smaller circular cross-section and a different method of bending, found strengths varying from 13.47 kg. per mm.^{2} to 41.1 kg. per mm.^{2}

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[4] A. Winklemann and O. Schott, Jena Glass and Its Scientific and Industrial Applications, Hovestadt, Macmillan Co.

[5] J. T. Littleton, Jr., *Phys. Rev.*, **5**, 510–16 (1923).

[6] J. T. Littleton, Jr., and F. W. Preston, *Jour. Soc. Glass Tech.*, **13**, 348 (1929).

[7] O. Graf, *Glastech. Ber.*, **3** [5], 153, 194 (1925).

[8] Brodmann, *Nachr. kgl. Ges. Wiss. Göttingen*, 44 (1894).

PROPERTIES OF SILICA BRICK MANUFACTURED FROM SHARON CONGLOMERATE[1]

By C. L. Fredrick, Jr.

ABSTRACT

New developments in the field of silicate refractories include greatly improved refractoriness and a high development of desirable qualities in silica refractories manufactured from Sharon conglomerate. The nature of silica refractories in general is discussed and a résumé of materials utilized in the manufacture of silica brick in the United States is given. Several illustrations of this new refractory are included, as well as test data.

I. Introduction

The art of manufacturing brick from the Sharon (Pottsville) conglomerate is not new. Thomas, in 1875, developed the process with both lime and clay bonds. There is, however, little or nothing recorded concerning properties of brick manufactured from this conglomerate.

In order to discuss adequately the properties of brick made from the Sharon conglomerate, it is necessary to use some criteria. The properties of the standard silica brick made of Pennsylvania materials and in Pennsylvania plants are used as this standard of test. These Pennsylvania products used for comparison represent an average of the standard product from the various producing fields in the state.

II. Statement of Work Done

(1) General The experimental work conducted consisted of tests made in three steel plants, several foundries, and high-grade alloy shops together with laboratory tests conducted by the author and by two noninterested laboratories. Wherever possible, tests of the samples under discussion were placed side by side with the standard samples thus giving as nearly as possible an accurate idea of the comparative values of each.

The samples taken as standard were three in number, two of Medina quartzite and one of Oriskany sandstone. All of the samples used were taken at random from their various hacks in the stock sheds of the refractories user.

(2) Analyses and P.C.E. Values The following tables are representative analyses taken over a period of actual operations and are indicative of the general character of the brick produced from conglomerate. Sample No. 1 is a selected pure white quartz pebble representative of the vein quartz from which the conglomerate has been derived. Sample Nos. 2, 3, and 4 are analyses of the brick produced there-

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., Canada, February, 1930 (Refractories Division). Revised copy received March 23, 1931.

from, while sample No. 5 is an average of brick produced from the Pennsylvania material.

The P.C.E. values above were obtained in a surface combustion K-20

TABLE I

ANALYSES AND P.C.E. VALUES

	1	2	3	4	5
SiO_2	98.00	96.67	95.14	95.89	96.26
Al_2O_3	0.91	0.34	1.07	1.56	0.88
Fe_2O_3	0.85	0.73	0.97	0.60	0.79
CaO	0.29	2.37	2.74	2.24	1.80
MgO	Trace	0.16	0.14	0.09	0.14
Ignition	0.005	0.04	0.05	0.13	....
Alkalis					0.39
Total	100.05	100.31	100.11	100.51	100.26
P.C.E. value	32–33	32–33	31–32	32	32–33

TABLE II

POROSITIES AND APPARENT SPECIFIC GRAVITY

Sample No.	Porosity	Apparent specific gravity
30–1	22.90	2.13
30–2	23.50	2.20
30–3	23.20	2.20
30–4	23.13	2.19
30–5	24.80	2.61
Mean	23.51	2.26
31–1	26.84	2.36
31–2	26.48	2.32
31–3	25.60	2.25
31–4	22.80	2.19
31–5	22.16	2.11
Mean	24.776	2.246
32–1	28.90	2.36
32–2	24.42	2.24
32–3	26.45	2.34
32–4	28.40	2.38
32–5	28.20	2.38
Mean	27.274	2.34
33–1	28.10	2.26
33–2	26.24	2.35
33–3	23.71	2.32
33–4	25.46	2.41
33–5	20.19	2.22
Mean	24.74	2.31

Volcanoe gas-fired furnace after first attempting to obtain them in an oxyacetylene furnace similar to that described by Gorton and Groves[2] and Shaw.[3] This, however, was discarded since it was found that the A.S.T.M.

[2] A. F. Gorton and W. H. Groves, "New Type of Oxyacetylene Fusion Furnace with Notes on Behavior of Refractories at Cone 40," *Jour. Amer. Ceram. Soc.*, **8** [11], 768–73 (1925).

[3] J. B. Shaw and G. J. Bair, "New Type High-Temperature Fusion Furnace," *ibid.*, **12** [7], 447–50 (1929).

schedule of heating could not be maintained with sufficient accuracy. Furthermore, the cones were found to flatten through the pressure and velocity of the flame.

(3) Porosity and Apparent Specific Gravity Porosity and apparent specific gravity were determined by the saturation method.

The samples designated as Series 30 included the conglomerate product while the remainder were of Pennsylvania material. The Series 33 included the brick manufactured from the Oriskany formation while the remaining two were composed of the Medina quartzite.

(4) Resistance to Abrasion Through the courtesy of L. D. Heustis of the Portsmouth By-Products Company, it was possible to obtain the data for the abrasion tests upon the original machine as described by Harvey and McGee.[4]

In coke-oven practice the abrasion factor is given serious consideration and great care is taken in inspecting and testing each allotment of refractories to insure the operators from failure through abrasion. The general practice is to expose the brick under test to the face of a 1-inch wide grinding wheel. Brick which the wheel does not penetrate over three inches during two minutes exposure are accepted as satisfactory. The results obtained are shown in Table III.

TABLE III
RESULTS OF ABRASION TEST
(Inches penetration 2-minute exposure)

Sample No.	1 Ohio	2 Pa.	3 Pa.	4 Pa.
1	2.75	4.00	4.89	4.35
2	3.80	3.75	3.50	3.50
3	3.25	3.60	3.70	3.25
4	3.10	2.75	4.50	3.45
5	3.60	2.60	4.40	2.00
Mean	3.30	3.34	4.20	3.31
Mean porosity	23.51	24.78	27.27	24.74

(5) Resistance to Spalling Because of the lack of sufficient laboratory equipment it is impossible to include any data upholding or setting forth the comparative values of any of the materials under test. It has been noted, however, by furnace operators and superintendents who reported that the brick composed from the conglomerate "seasoned" faster than the other samples, and while the brick spalled there was not so large a percentage lost as in the case of the other tests. They further report that after the original spall, which occurred during the glazing or "seasoning," the brick from the conglomerate suffered but little spalling through the remainder of the campaign.

[4] F. A. Harvey and E. N. McGee, "Factors Affecting the Resistance of Silica Refractories to Abrasion," *Jour. Amer. Ceram. Soc.*, **7** [12], 895–906 (1924).

III. Service Applications

(1) Acid Open Hearth In acid open-hearth service the Sharon brick were in every sense of the word the equal of other silica brick. The greatest difference between the standard brick and the samples lay in their ability to withstand thermal and mechanical shock better than the brick in general use. The author has no laboratory data to reinforce this statement which is warranted only by the comments of superintendents, heaters, and masons on furnaces in which the brick have been used.

Roof life was greatly increased in one plant as evidenced in the accompanying photographs. Figure 1 shows ten standard 9-inch brick that formed a part of the roof of an open-hearth furnace through a campaign of 313 heats. This furnace was fired with a combination of "coke braize"

FIG. 1.

and producer gas during the campaign; the previous average life had been but 250 heats. In the roof the tests were placed side by side, that is, samples Nos. 5 and 6 were together, 4 and 7, 3 and 8, and so on with Nos. 5 and 6 closest to the top of the crown. The tape stretched above the samples represents the original height of the brick. From this comparison it may readily be seen that the Sharon samples, Nos. 1 to 5, suffered far less erosion than the Medina samples, Nos. 6 to 10. In the instance of samples No. 1 and No. 2, sufficient glaze was deposited to exceed the original 9-inch dimension. Since the preliminary tests in the roof were made, three different types of roofs have been placed in service with excellent results by three different users.

Complete open hearths have shown the equality in worth between the brick manufactured from Pennsylvania materials and those that are being manufactured today from the conglomerate.

(2) Hot Patching Of especial interest to operators is the ease with which "hot patches" can be made with the Sharon brick. The patching may go forward just as fast as masons equipped with asbestos suits can place the brick, even though the furnace be maintained

at full heat. This quality has enabled one plant to report the most consistent operation of their open hearths with fewer and shorter shut-downs than had ever before been possible in their organization.

(3) Soaking Pit In soaking-pit service a battery of pits was built using half Sharon and half Pennsylvania brick. Figures 2 and 3 show the appearance of the relative tests after ninety days of service. In Fig. 2 the end wall is shown, which is subject to the bumping and tearing of the in-swinging ingots, as well as the sudden thermal shock when the pit is opened and fresh ingots are introduced. In this end wall the brick are manufactured from the conglomerate. At the time the photograph was taken there were no signs of cracking or spalling. A good idea of the appearance may be obtained by examining the arch at the bottom of the cut.

FIG. 2.

Figure 3 shows the opposite end of the same pit which was built up of Pennsylvania brick, as were both the side walls. This end wall is opposite that shown in Fig. 2 and is more or less protected from the in-swinging ingots by the cover which rests on this side when the pit is opened for charging or withdrawing. The arch on this end exhibits some signs of checking and cracking. In the end walls, as well as the side walls may be seen patches where the glazed surface has spalled exposing fresh white, unaffected surfaces. Although the ninety-day period is not indicative of the eventual life it was thought that any differences in wear would show within that period. This has since proved to be true, for upon recent examination little change can be detected and the lining has given eighteen months' service.

FIG. 3.

(4) Boiler Fire Boxes Silica brick have never been extensively used in lining the fire boxes of boilers. Nevertheless an opportunity to make a test under conditions where first-quality fire brick were failing repeatedly was promptly accepted. In this particular installation the boiler was fired with coal and wet sawdust which carried considerable tannic acid and furniture glue with it, the sawdust amounting to

nearly 75% of the fuel used. Under these conditions the fire boxes had burned out clay linings from the best plants of Pennsylvania, Ohio, and Kentucky. One wall was therefore constructed of the Sharon brick and the opposite wall of a first quality clay brick from an outside manufacturer. Figure 4 shows the results after forty-five days' use, the left wall being the silica.

While not being at all comparative it is interesting to see the resistance of the brick under a diversity of fuels and conditions.

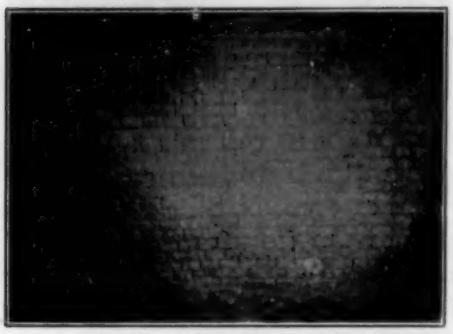

FIG. 4A.

(5) Electric Furnace Three electric furnace roofs have been placed in service using the conglomerate material and all have been unusually successful. In this particular installation the roof was placed on a seven-ton Moore "Lectromelt" furnace engaged in the production of high-grade steels and alloys. Each of the linings and roofs was exposed to "burning in bottom," linings and roof wearing out together. It is not unusual for one lining to outlast two sets of roof blocks. Upon the results obtained from these three roofs it was found that the Sharon conglomerate roof averaged twenty-eight days' use compared with eighteen days' service obtained from roofs composed of the Pennsylvania materials. In another installation the entire design of the roof was materially altered without incurring any refractories difficulties in the manufacture of small steel castings from scrap.

FIG. 4B.

(6) Miscellaneous Uses The conglomerate has proven itself equal to the quartzite in many miscellaneous applications such as cupolas, glass-tank checkers, gas-producer sets, welding and forging furnaces where fluxes are in use, sheet furnaces, lime kilns, billet furnaces, spike furnaces, and various types of burner blocks. This brick with clay brick to compensate for expansion has been used in kilns satisfactorily. In nearly all of these applications the operators have ac-

cepted the brick of the conglomerate to be on a par with those manufactured from the quartzites and sandstone in the various producing districts of the country.

IV. Summary of Tests

In every instance where comparative tests have been possible between brick manufactured from Pennsylvania quartzite and those manufactured from the Sharon conglomerate, users have found the two brick to be equal within certain limits. One installation perhaps favored the quartzite brick and the next placed the remainder of proof on the brick from the conglomerate. Therefore in summarizing the results obtained in practice and in the laboratory we are convinced that there is a future for the brick manufactured from the Sharon conglomerate and that it is fully equal to average silica brick found in use today.

There are many angles and possibilities in this material that invite future testing and experimentation and with this thought the author offers this paper as a preliminary survey of the properties and characteristics of refractories having as their base the Sharon conglomerate.

PORTSMOUTH REFRACTORIES CO.
PORTSMOUTH, OHIO

THE ESTIMATION OF THE ALUMINA CONTENT OF DIASPORE AND BURLEY CLAY FROM THE SILICA CONTENT[1]

By M. E. Holmes[2] and W. D. Keller[3]

ABSTRACT

The formula, % Al_2O_3 = 0.85 × % SiO_2 + 0.85 (100 − 2.15 × % SiO_2) − 5.1, is presented for use in estimating the per cent of Al_2O_3 of diaspore and burley clays. The silica determination is quick enough and cheap enough to make control testing of carload shipments practicable. The method applies to the lowest-grade burley as well as the highest-grade diaspore. The results of 381 actual analyses are presented showing that the method is accurate to 1% in 65% of the tests and to 2% in 89% of the tests.

I. Introduction

The broadening uses of diaspore and burley clays, their increasing scarcity, and the variation from quarry to quarry and within individual quarries are factors back of the increasing need for more detailed classification and grading of these materials.

Rough field methods for classifying and grading diaspore and burley clays, accurate perhaps to 5% of the alumina content, have been described.[4] These methods involve observations of the mark left by metallic tools, the feel, the fracture, the sound when struck, the prominence of the oölites, the grain, and the weight of the specimen. These methods suffice for the rough sorting of the material into two or three grades at the quarry. The material, however, must be graded into a larger number of groups of shorter ranges of quality and mixed in various proportions, both being done quite accurately, to meet the refractories manufacturers' requirements.

A chemical analysis costs too much and requires too much time for control in grading diaspore and burley clays.

Various short methods have been proposed. Robitschek[5] suggests the determination of the alumina with 8-hydroxyquinoline, a determination which can be made in a few hours. Methods based for the most part on the differences in specific gravity between the grains of diaspore and the accompanying minerals have been proposed by Wherry[6] and McQueen.[7] Phelps and Hughes[8] have published a method based on the same principles.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Refractories Division). Received January 31, 1931.

[2] Professor of Ceramic Engineering, Missouri School of Mines and Metallurgy, Rolla, Mo.

[3] Ceramic Technologist, A. P. Green Fire Brick Co., Mexico, Mo.

[4] *Brick Clay Rec.*, **75** [8], 492–96 (1929).

[5] *Jour. Amer. Ceram. Soc.*, **11** [7], 587–94 (1928).

[6] "Field Identification of Diasporite," *Amer. Mineralogist*, **3**, 154 (1918).

[7] Unpublished work of the Assistant State Geologist of Missouri.

[8] "A Rapid Method for the Estimation of the Alumina Content of Diaspores and High Alumina Clays," *Jour. Amer. Ceram. Soc.*, **13** [1], 1–4 (1930).

Forbes[9] proposed and used the plan of determining the silica, adding an average figure for impurities, and substracting the sum from 100% as a means of the rapid estimation of the alumina content.

The substitution of the silica determination for the alumina determination reduces the cost 60% and the time to such an extent that the test can be made and reported by wire while the material is in transit.

TABLE I

Sample	Actual SiO_2 content	Actual Al_2O_3 content	Al_2O_3 calculated from the formula given above	Correction factor
1	19.45	62.71	65.98	−3.25
2	10.56	70.26	74.67	−4.41
3	21.05	59.90	64.43	−4.53
4	25.66	52.43	59.89	−7.46
5	22.75	55.33	62.42	−7.07
6	15.42	62.31	69.93	−7.62
7	13.50	66.65	71.83	−5.18
8	27.80	52.06	57.06	−5.86
9	34.66	45.43	51.11	−5.61
10	26.06	54.34	59.52	−5.18
11	23.38	56.26	62.15	−5.88
12	14.88	66.63	71.38	−4.75
13	39.10	40.66	47.72	−7.06
14	16.33	63.27	69.03	−5.75
15	32.80	47.62	57.36	−5.32
16	20.80	60.08	65.51	−5.43
17	39.58	43.25	46.30	−3.05
18	29.28	49.97	56.38	−6.41
19	18.31	60.86	67.10	−6.24
20	35.06	45.02	50.73	−5.71
21	31.70	50.24	54.00	−3.76
22	7.85	73.89	77.32	−3.43
23	8.31	72.15	76.87	−4.71
24	31.56	48.83	54.15	−5.32
25	17.89	62.30	67.52	−5.22
26	8.27	72.27	76.84	−4.67
27	6.35	73.61	78.70	−5.09
28	10.90	69.76	74.35	−4.59
29	12.59	68.81	72.69	−3.88
			Average	−5.12

NOTE: High-alkali and high-iron diaspore and burley clays are not included in the materials covered by this report. Only materials used in making refractories are considered.

An examination of a large amount of analytical data indicated a relation between the silica and alumina content and it suggested that diaspore and burley clays consisted mainly of the minerals, diaspore, and kaolinite, and that the prime difference between the various grades of burley and diaspore clays is the relative amounts of these two minerals.

II. Development of the Method

If diaspore and burley clays consisted of varying mixtures of kaolinite

[9] "Winning of Missouri Diaspore, Burley, and Flint Clays," *Jour. Amer. Ceram. Soc.*, **11** [3], 204–14 (1928).

and diaspore only, their mineral composition could be expressed by the general formula

(1) $x Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O + y Al_2O_3 \cdot H_2O$.

(2) Total $\%Al_2O_3 = \%Al_2O_3$ in the kaolinite + $\%Al_2O_3$ in the diaspore.

(3) Since in kaolinite $\frac{Al_2O_3}{SiO_2} = \frac{102.2}{120.2}$ or 0.85, the $\%Al_2O_3$ from kaolinite equals $0.85 \times \%SiO_2$ content of the clay.

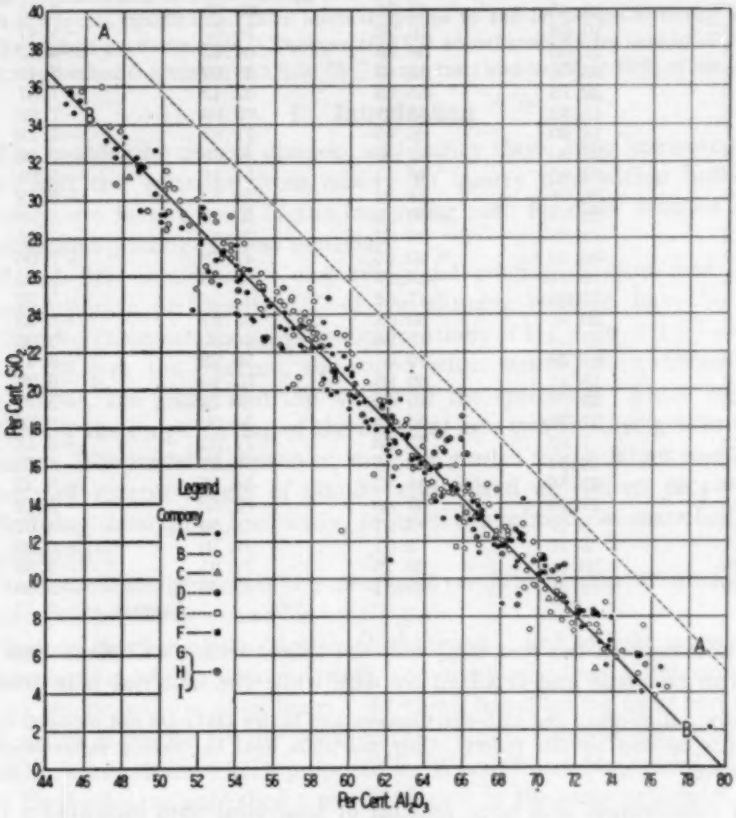

FIG. 1.—Silica–alumina relation of Missouri high alumina clays.

(4) Since all the SiO_2 is present in kaolinite the percentage of kaolinite present can be calculated from the ratio of $\frac{\text{kaolinite}}{\text{silica}} = \frac{258.1}{120.2} = 2.15$. Therefore, per cent kaolinite equals $2.15 \times \%SiO_2$.

(5) Per cent diaspore $= 100 - (2.15 \times \%SiO_2)$.

(6) Since the Al_2O_3 content of pure diaspore is 85%, the $\%Al_2O_3$ in the clay from diaspore $= 0.85 \times (100 - 2.15 \times \%SiO_2)$.

(7) Per cent Al_2O_3 in the clay $= 0.85 \times \%SiO_2 + 0.85\ (100\% - 2.15 \times \%SiO_2)$. The curve of this equation is given as curve *A* in Fig. 1.

To determine the necessary correction factor, the analyses of 29 samples of burley and diaspore clay were used. They ranged in silica content from 6.35 to 39.58%. Table I gives from chemical analysis the silica and the alumina content. Column 4 gives the Al_2O_3 content as calculated by equation (7) above. The last column gives the correction factor.

The calculated Al_2O_3 content is consistently high. The correction factor averages 5.12. It represents the impurities and does not increase or decrease with the variation in silica or alumina. This indicates a quite uniform amount and kind of impurities throughout the range from low-grade burley to high-grade diaspore. This means a straight curve as shown in curve *B* (Fig. 1) and as indicated by the absence of any factors of multiple powers in the final form of the equation as follows:

(8) Per cent $Al_2O_3 = 0.85 \times \%SiO_2 + 0.85\ (100 - 2.15 \times \%SiO_2) - 5.1$.

III. Accuracy of the Method

To check the accuracy and dependability of curve *B* and formula (8), the results of the analysis of 381 samples of burley and diaspore clays, taken at random from the files of the Missouri Clay Testing and Research Laboratories, were plotted along the curve using the alumina content as abscissa and the silica content as ordinate. These 381 analyses represent samples sent in over a period of about one year by nine different companies, several of the companies operating several pits. Furthermore, these analyses include values ranging from 40 to 79% Al_2O_3 content. It would seem that these data are comprehensive and extensive enough to offer ample proof of the dependability of the method.

The curve occupies a median position among the actual values for the Al_2O_3 content throughout its course from the lowest-grade burley to the highest-grade diaspore; 64.3% of the calculated values are less than 1% in error, 88.7% are less than 2% in error, and 99.7% are less than 3.5% in error. This would seem to establish the worth of the method. The conclusion is supported by the successful use of the method by one company over a period of more than a year.

Acknowledgment The authors are indebted to the A. P. Green Fire Brick Company for making this investigation possible and for releasing it for publication.

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THE SPECIFIC HEAT OF MAGNESIUM AND ALUMINUM OXIDES AT HIGH TEMPERATURES[1]

By Gordon B. Wilkes

ABSTRACT

The mean specific heat of pure aluminum and magnesium oxides has been determined from room temperature up to 1700°C and 1800°C, respectively. The specimens were heated in a vertical carbon tube furnace with a magnesite tube liner for oxidizing conditions. A special calorimeter was designed and used to prevent the loss of heat by vaporization of the water when the white hot specimens were immersed.

I. Introduction

The Chief of Ordnance, War Department, requested the writer to develop an apparatus for the determination of the specific heat of refractory oxides at high temperatures. In connection with this work, the specific heat of magnesium oxide and aluminum oxide was determined over a range of temperature extending from 20 to 1800°C.

The method chosen was a modification of the familiar method of mixtures in a water calorimeter.

II. Test Specimen

The materials for the samples were C.P. aluminum oxide from Baker and Adamson and magnesium oxide U.S.P. from the Powers-Weightman-Rosengarten Company. These oxides were calcined at approximately 1800°C, mixed with a little water, and molded into cylinders $^3/_4$ inch in diameter and from 1 to 2 inches long. In the top of the specimen a $^1/_4$-inch hole was drilled extending almost through the sample to give approximate "black body" conditions when using the optical pyrometer and to serve as a place to insert the thermocouple when measuring the temperature of the specimen by that method.

III. The Furnace

The furnace consisted of a carbon tube connected by a ground joint at each end to a graphite ring, which was in turn clamped by a bronze casting to which the leads of the transformer were fastened, the casting being water cooled as shown in Fig. 1.

The carbon tube was set vertically inside an asbestos-wood box and packed with crushed coke to prevent oxidation.

To obtain an oxidizing atmosphere around the specimen, a special magnesite tube was used as a liner for the carbon tube. A small shelf was made on the inside of the magnesite tube to serve as a support for the specimen. Numerous schemes were tried for this support but all were open to some objection at 1800°C with the exception of this elementary method of support.

[1] Received April 1, 1931.

The transformers connected to the furnace were arranged to give a wide variation in voltage, thus permitting the furnace to be operated at any desirable temperature.

IV. The Calorimeter

The calorimeter was an Emerson bomb calorimeter with a Daniel "adiabatic" jacket similar to those used for the determination of the heat of combustion of fuels.

When using the method of mixtures with specimens at relatively low temperatures, it is customary to immerse the specimen directly in the water; but in this case, with temperatures as high as 1800°C, the formation of steam would be so violent that it would introduce serious errors into the determination. The satisfactory means finally adopted was a small brass container with a spring cover which could be set in the calorimeter in such a manner that the top was just above the water level. When the specimen was dropped from the furnace into the container, the cover was automatically closed and the whole container immediately immersed in the water. A little water would leak through the cover into the container and this would be partially converted into steam, but it was never of sufficient volume to reach the surface of the water in the calorimeter.

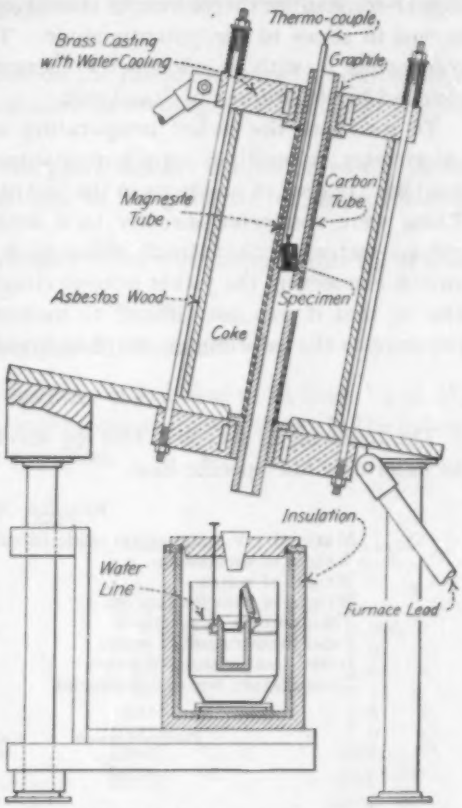

FIG. 1.—Sketch of apparatus for specific heat determinations.

V. Temperature Measurements

The temperature of the specimen was measured whenever possible by means of a thermocouple inserted in the $^1/_4$-inch hole in the specimen. At extremely high temperatures an optical pyrometer of the disappearing-filament type was used, sighting down the $^1/_4$-inch hole.

The thermocouple was a standard platinum, platinum-10% rhodium couple with the cold junction kept in a thermos bottle filled with cracked ice and water. A Leeds and Northrup precision thermocouple potentiometer was used that could be read directly to 0.001 millivolt and estimated to 0.0001 millivolt. The couple was calibrated by using the freezing points of zinc, aluminum, and copper.

The calorimeter temperature was measured by means of a multiple copper-constantan thermocouple consisting of four complete junctions connected in series to the potentiometer. This couple was standardized by comparing it with a calorimeter thermometer that had been recently checked by the Bureau of Standards.

To maintain the jacket temperature at the same temperature as the calorimeter, a multiple copper-constantan couple of three junctions was used with one set of junctions in the jacket and the other in the calorimeter. These were connected directly to a sensitive Leeds and Northrup wall galvanometer so that small differences could be readily detected. A switch connecting the jacket heating circuit was placed near the galvanometer so that it was not difficult to maintain the jacket at the same temperature as the calorimeter and thus avoid all radiation corrections.

VI. A Test Log

The following is a typical test log sheet with the necessary calculations to determine the specific heat.

RUN No. 76

Material, C.P. magnesium oxide (fired at 1800°C)	
Weight of specimen	36.14 g.
Weight of water	1800 g.
Weight of calorimeter, etc.	1079 g.
Temperature of specimen	913.5 °C
Final temperature of water	26.761°C
Initial temperature of water	22.058°C
Temperature rise in calorimeter	4.703°C

Time	Platinum couple (mv.)	Calorimeter couple (mv.)	Jacket couple (cm.)
1:04	8.522		−0.2
1:05		3.6133	−0.15
1:06	8.522		−0.1
1:07		3.6148	0.0
1:08	8.523		0.1
1:09		3.6163	
1:09:30		3.6167	Specimen dropped
1:10			0.0
1:11			−0.5
1:12			−2.9
1:13			0.3
1:14			1.7
1:15			1.6
1:16			1.3
1:17			1.1
1:18		4.4042	0.95

Time	Platinum couple (mv.)	Calorimeter couple (mv.)	Specimen dropped
1:19		4.4068	0.8
1:20		4.4088	0.7
1:21		4.4090	0.65
1:22		4.4093	0.60
1:23		4.4093	0.60

Calculation of mean specific heat between 913.5°C and 26.8°C

$$\text{Specific heat} = \frac{(1800 + 1079 \times 0.095)(4.703)}{(36.14)(913.5 - 26.8)} = 0.2791 \text{ gram calories per gram per °C.}$$

In the above run, 0.001 millivolt on the platinum couple is equivalent to approximately 0.1°C. On the calorimeter couple, 0.0001 millivolt is equal to about 0.0006°C.

One centimeter deflection of the galvanometer connected to the jacket thermocouple indicates a difference in temperature of approximately 0.25°C.

The specimen was kept in the furnace at constant temperature for at least one hour before a test was made.

VII. Precision Attainment

It was desirable that the results have a precision of at least $^1/_2$ of 1% and the allowable error in the various measurements is shown in the following table in order to secure this precision.

TABLE I

	Approximate value	Allowable error
Weight of water in calorimeter	1800 g.	9 g.
Weight of calorimeter, etc.	1079 g.	50 g.
Specific heat of calorimeter, etc.	0.095	0.005
Initial temperature of water	23.000°C	0.01 °C
Final temperature of water	27.000°C	0.01 °C
Weight of specimen	30.00 g.	0.15 g.
Temperature of specimen	500 °C	2.4 °C
	1000 °C	5.0 °C
	1500 °C	7.5 °C
	1800 °C	9.0 °C

All of these measurements were made within this allowable error.

The chief unaccounted errors were as follows:

(1) Loss of Weight A large number of specimens were weighed before and after the test and the loss due to abrasion was found to be negligible.

(2) Loss of Heat The loss of heat from the specimen during transfer was considered negligible due to the extremely small amount of time required for the specimen to fall about one foot.

(3) Steam Formed in Calorimeter There was no indication of the formation of steam at any time when the specimen went into the calorimeter.

(4) Temperature Not Agreeing with Thermocouple With the thermocouple actually inserted inside of the specimen and the time taken to insure a balanced temperature condition, this error is extremely small.

(5) Nonblack Body Conditions for the Optical Pyrometer The thermocouple was checked against the optical pyrometer in a number of runs and it was noticed that in the case of the magnesium oxide specimens the optical pyrometer read slightly lower than the thermocouple. This was probably due to poor black body conditions and consequently the thermocouple was used up to 1500°C and the optical used only at the highest temperatures.

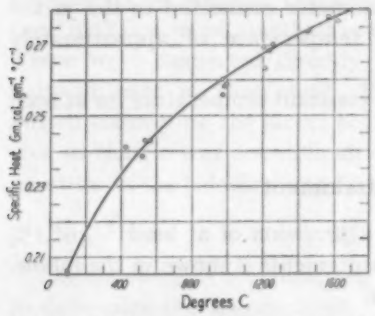

FIG. 2.—Mean specific heat of aluminum oxide from 30 to t°C.

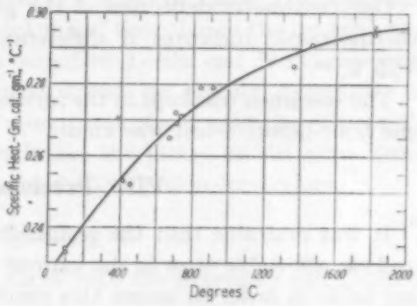

FIG. 3.—Mean specific heat of magnesium oxide from 30 to t°C.

TABLE II

MEAN SPECIFIC HEAT BETWEEN t°C AND 30°C

t°C	Aluminum oxide	Magnesium oxide
100	0.2060	0.2335
300	0.2260	0.2470
500	0.2395	0.2590
700	0.2500	0.2690
900	0.2580	0.2765
1100	0.2645	0.2825
1300	0.2705	0.2875
1500	0.2755	0.2910
1700	0.2800	0.2935
1800		0.2945

(6) Radiation of Heat between Jacket and Calorimeter Test runs were made with various known differences of temperature between the jacket and the calorimeter. It was found that there was no appreciable error from this cause.

Thirty-two runs were made on the two oxides as indicated in Figs. 2 and 3. The average results are shown in the table.

Acknowledgment The author wishes to acknowledge the assistance of O. Kenneth Bates and George Thomson of the staff of the Massachusetts Institute of Technology, who made most of the determinations.

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FIRING STRUCTURAL TILE[1]

By T. W. Shook and G. R. Sylvester

ABSTRACT

The modern railroad-car tunnel kiln can fire structural tile economically in sufficient quantities for commercial operation. The setting arrangement is important both as to arrangement of flues and also as to the stability of the structure. Various sizes of tile can also be placed on the same car. There are approximately three tons of tile on each car. The kiln used is a Harrop car tunnel kiln, 350 feet long with a cross-section of 5 feet 8 inches by 5 feet 5 inches. Either oil or powdered coal is used as fuel. The tile are in the kiln a total of 29 hours, giving a total production of 130 tons per twenty-four hours.

I. Introduction

A description is given of the successful operation of a direct-fired tunnel kiln firing structural tile at the plant of the Ohio Clay Company in Cleveland. The kiln was constructed in 1923, but was not operated regularly on structural tile until May, 1929.

The green tile (4 by 5 by 12 inches and 5 by 8 by 12 inches) are placed on standard drier cars in the machine room and dried in a 3-tunnel waste-heat drier, the heat being supplied from the cooling end of the tunnel kiln.

There are two parallel tracks, one for drier cars and one for kiln cars. The drier car track is on a dock at the same level as the top of the kiln cars. Kiln cars fill the entire kiln car track and are moved by a hydraulic pusher located at one end of the track. The car platforms thus constitute a continuous platform similar to a moving section of floor. The men employed in placing tile merely transfer the tile from the drier cars to the moving kiln cars in a properly arranged setting.

II. Setting of the Tile

Assuming that the kiln is properly proportioned and the heat properly applied to the tunnel, the actual setting arrangement on each car is probably the most important point to be considered in firing structural tile uniformly in tunnel kilns.

At first it seemed best to place the tile so that all cells would be parallel to the direction of gas travel. With this particular type of tile, however, this resulted in a tendency to crack the tile in the lower part of the setting if the webs of the tile were not in perfect vertical alignment. All of the superimposed load is also carried by the webs of the lowest course, which gives the webs a tendency to lean sidewise, sometimes collapsing the tile and destroying the stability of the entire setting. In addition, in this

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Structural Clay Products Division). Revised copy received August 15, 1931.

type of setting, it is difficult to arrange tie courses without which the entire setting will likely roll, due to unequal shrinkage.

The setting finally developed has the maximum flue spaces and stability. The longitudinal flue in the center of the car setting is used in direct-fired horizontal draft kilns to control the relative amounts of combustion gases traveling along and through the center of the setting.

By providing one or more longitudinal flues in the setting, the time of heat penetration of the ware is reduced, which in turn makes possible a greater output.

Because hot gases tend to rise in an atmosphere of cooler gases, there is a pronounced tendency for the large part of the hot gases to travel along the crown, much like an inverted river. By obstructing free travel of the

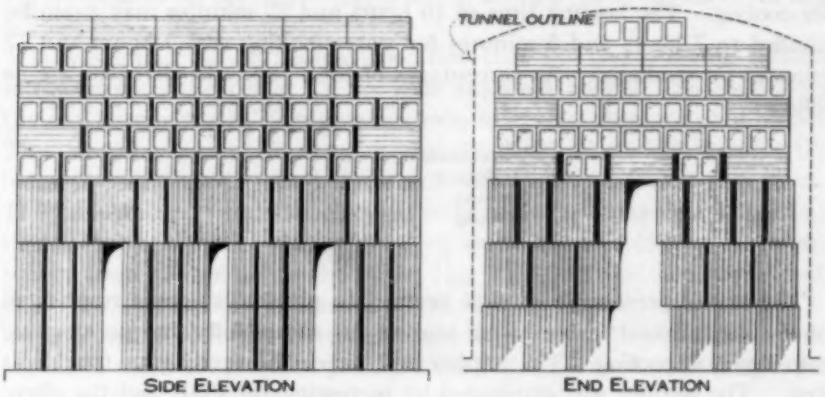

FIG. 1.

hot gases in the upper portion of the tunnel, these gases are forced down and travel at a lower level. This is done by making the passages narrower at the top than at the base. This also gives greater structural stability, and the battered kiln wall aids in forcing the hot gases to the bottom of the ware setting.

The three lower courses of tile are placed on end to give stability and resistance to crushing. It is a simple matter to place the tile on end in the lower courses, but above the level of a workman's elbows, it is much easier to place the tile flat.

The number of tile with the cells parallel to the direction of car travel is determined by the amount of heat necessary to fire the tops of the loads properly. The tile placed at right angles to the direction of car travel act as baffles, forcing the hot gases to the lower parts of the setting and also, in controllable amounts, to the top center of the load.

There are three hundred and seventy-one 5- by 8- by 12-inch tile on each

car, weighing approximately three tons. With this loading, the dimensions of the setting on each car are 6 feet 6 inches in length, 5 feet in width, and 5 feet 5 inches in height.

III. The Kiln

The kiln has previously been described.[2]

Automatic temperature control enables one man per shift to take care of all transfers and also the fireman's duties.

(1) Schedule At the time these observations were made, a car entered the kiln every 32.7 minutes or a total of 44 cars every 24 hours. With this rate of travel as a basis, one car required 28 hours and 54 minutes to pass entirely through the kiln, 16 hours and 22 minutes for heating, 2 hours and 44 minutes for soaking, and 9 hours and 48 minutes for cooling. The heating time of 16 hours and 22 minutes may again be divided to 7 hours and 5 minutes for watersmoking and 9 hours and 17 minutes for oxidizing. As percentages of total time, the divisions are as follows:

	(%)
Watersmoking	24.5
Oxidation	32.0
Soaking	9.4
Cooling	34.1
	100.0

The above percentage of time seemed to give satisfactory results, all of the sulphur and carbon being burned out successfully and no cracking developing in cooling. The sulphur and carbon, however, gave trouble at first. The sulphur was eliminated by increasing the draft and the circulation through the charging end of the kiln. The carbon was successfully burned out by making slight changes in the setting and by increasing the draft causing more air to travel through the setting, thus burning out the organic matter.

All cooling difficulties were overcome by making a few setting changes to permit a more uniform spread of cooling air over the entire cross-section of the car.

The production in June, 1931, was 3352 tons of ware and fuel consumption was 579,600 pounds of coal.

(2) Fuel The kiln is equipped with two fuel systems, fuel oil and pulverized coal.

The oil system is always used in starting, after the kiln for any reason has been cooled off. Changing from oil to coal or vice versa is readily accomplished approximately in 20 minutes.

[2] Frank M. Hartford, "Successful Application of Powdered Coal as a Tunnel Kiln Fuel Firing Hard-Fired Common Brick," *Jour. Amer. Ceram. Soc.*, 9 [10], 684–89 (1926).

(3) Powdered Coal System The powdered coal system installed on this kiln is rather unique. The system is noncirculating, no coal being returned to the supply. The flow of coal is controlled before pulverizing to produce the required temperature.

The uncrushed coal is fed by a disk feeder to an air-swept ball mill. The air current passing through this mill carries the pulverized coal to a horizontal distributing fan from which the coal is delivered equally into ten branches, one leading to each furnace. The current of air passing through the mill is controlled by the distributing fan speed by means of a variable-speed slip ring motor. The current of coal and air is mixed with secondary air at the burners for flame control.

Since the ash of the coal has a higher fusion temperature than the maturing temperature of the hollow tile, it can be blown off after the car of tile has left the kiln.

It was found during manual operation that one thermocouple located in the crown of the kiln at the fire zone was a key couple. By controlling the coal supply from this couple, uniform firing was obtained at all times. This control is accomplished by driving the disk feeder which supplies the ball mill with two different motors, each with slightly different gear ratios. The temperature control mechanism is actuated by variations in the key thermocouple, resulting alternately in an automatic switching of the power supply from one motor to the other, thus changing the feed to the ball mill. This gives more uniform heat than was previously obtained.

When firing with powdered coal, approximately 173 pounds are used per ton of tile. With coal at $3.00 per ton delivered, the fuel cost amounts to 26 cents per ton of fired tile.

(4) Coal versus Oil Coal has the advantage of low first cost, uniform firing, steady supply, and low labor cost. In fact, with automatic control, less labor is required for coal than for oil. Also, superior firing results on fast schedules are obtained with coal, due to the delayed combustion of this fuel.

Oil being merely a standby fuel, no attempt has been made to install automatic temperature control on the oil system.

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SALT GLAZING A CLAY OF LOW VITRIFYING TEMPERATURE[1]

By H. F. Dingledine

ABSTRACT

The method used to secure a salt glaze on a red-firing clay which vitrifies at a temperature too low to salt glaze normally consists essentially of raising the temperature quickly for short intervals by rapid combustion of thin soft-wood edgings and applying the salt at maximum temperature during several successive intervals.

I. The Clay

A plastic surface clay is used in the manufacture of sewer pipe, fittings, wall coping, and other salt-glazed vitrified products. This clay is the product of weathering of a shale which lies adjacent and underneath it. The parent shale runs too high in lime and magnesia to salt glaze, the combined content varying approximately from 3 to 8%. During the long period of weathering, the lime content in the weathered clay has been reduced by leaching to an average of less than 1%.

This weathered clay fires to a clear red, is quite plastic, and is of fair drying behavior, although the total shrinkage is rather high. Drying shrinkage is about 5½% and firing shrinkage is about 6% at cone 02. The vitrification range is short, being less than 40°F or about two cones.

Vitrification is practically complete at cone 02, the absorption at this point being 2% or less, and the body rapidly deforms at any temperature beyond this point.

The clay will not take a salt glaze at cone 02, even though practically vitrified, and it is necessary to use the following method to secure a good salt glaze.

II. Firing

The products are fired in round downdraft kilns varying from 32 to 38 feet in diameter. The kiln is brought up through the usual stages in a manner similar to sewer pipe practice, but great care is exercised in the latter stages to insure a red, oxidized body throughout and to have the top and bottom courses of the kiln as nearly uniform as possible. Both pyrometric cones and pyrometers are used and it has been possible to bring the kilns to the finishing point with not more than 2 cones difference between top and bottom courses with a good degree of consistency.

At this finishing point, a bundle of soft-wood edgings is pushed into each fire box and a medium shovel of salt is thrown in by the usual method. The effect of the rapid combustion is to create a reducing atmosphere and a much higher temperature lasting for 10 or 15 minutes. This treatment is repeated at about half-hour intervals until three or four rounds of

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Structural Clay Products Division).

edgings and salt have been fired. The fires are pushed in and plenty of air is allowed in order to cool the surface of the ware rapidly. After two or three hours, the fire boxes are sealed to prevent the entrance of air which causes air checking. The kilns are then cooled carefully.

III. Results

The temperature at the surface of the ware is raised to incipient fusion without unduly softening the body, and the salt vapors combine readily with the glassy surface to give a good glaze. The kiln temperature is thus raised 60 to 80°F in five minutes by this method and held only a short time, thereby preventing deformation.

The reducing condition has the effect of darkening the color at the surface and the reduction, as shown by the finished ware, does not usually penetrate over about $^1/_8$ inch.

The wood edgings are simply a by-product of lumber mills where hemlock, spruce, or pine flooring and lathe are made and are from $^1/_2$ to $1^1/_2$ inches thick, 1 to 2 inches wide, and 4 feet long. They are tied in bundles about 8 inches in diameter at the mills and sold by the cord.

The cost of firing is not materially increased as the wood replaces coal. This method has been in practical use for many years.

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AN AUTOMATIC DEVICE FOR PRODUCING A CURVE COÖRDINATING SHRINKAGE AND DRYING LOSS[1]

By H. Spurrier

ABSTRACT

An apparatus is described which automatically plots a curve and coördinates the shrinkage associated with the drying loss at any point on the curve. From such curves correct drying schedules may be developed. The apparatus may be used in a drier to indicate correct drying performance and the curves furnish valuable information as to the drying peculiarities of bodies not usually available.

I. Purpose

The practical value of results obtained by coördinating shrinkage and drying characteristics naturally led to the speculation as to whether this could be done automatically. Two desirable results would be achieved if such a device were found, (1) the amount of attention required would be greatly reduced, and (2) the personal factor would be practically eliminated.

II. The Instrument

The instrument shown in Fig. 1 is the result of the above theory and as a consequence of its behavior it has an advantage which the previous models did not possess, in that the graphs it makes may be used to plot the most advantageous drying schedule for commercial driers and in addition, by the plot it traces in a drier, the correct performance of the drier may be determined as the operation proceeds.

The machine is primarily made up of three sets of parts: (1) those relating to the shrinkage characteristics, (2) those relating to the loss of water, and (3) the recording device.

The shrinkage effect is recorded in a horizontal direction from left to right. The test bar under observation is of 200-mm. length and is supported on an Invar steel frame in a vertical position. On its upper end rests a face plate and bar which communicate the shrinkage movement to the short horizontal arm of a right angle lever, at a point exactly 30 mm. from the common center of rotation of the two arms. The long vertical arm of the lever is slotted so as to carry a slide which moves in a horizontal guide and the center of the screw which connects the long lever to the slide is exactly 180 mm. above the common center of the two lever arms. This arrangement gives to the slide a horizontal movement which is sixfold that of the vertical movement due to shrinkage. In other words, since the angular movement of the two attached levers is the same, a point

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Terra Cotta Division).

six times as distant from their center of rotation will move six times as far as a point which is only one-sixth of that distance.

The frame carrying the levers is suspended upon the lower end of a helical spring, the function of which is to make evident the decrease in weight of the test bar consequent upon its drying out.

That this system should have the required sensitiveness, it was necessary that the spring should be quite delicate and since the suspended system with the clay bar weighs over 500 grams, a considerable difficulty was encountered. This was overcome by attaching a strong fine silk cord to the lower end of the spring and passing it over a large light pulley wheel which is delicately balanced and mounted on light running friction wheels. The terminal end of this cord carries a balance weight, the effect of which, when adjusted, is to cancel out the dead weight of the suspended system, so that the function of the spring is solely to record the changes in weight due to the loss of moisture.

Upon the heavy steel upright is a spider carrying a true plane glass plate which is adjustable in three directions. This plate carries a 6- by 6-sheet of millimeter cross-section paper. A slight prolongation of the screw which connects the long lever with the slide carries the recording pen. The recording pen presented quite a difficulty because a fine line was desired and there could be no sticking. A satisfactory pen, however, was devised. An electrical buzzer is mounted on the steel rod and is kept in action during the use of the machine.

FIG. 1.

III. Method of Use

To use this machine, it is first of all levelled by the screw feet, then the chart holder is set at the right height and made vertical by its set screws. The spring is quickly calibrated by noting its extension on the addition of a 50-gram weight and also a 20-gram weight for safety. From the descent divided

by 50 or 20, as the case may be, the descent for one gram is calculated; with this particular spring it is 2.6.

The weighed clay bar is put in place and the system is balanced by adding shot to the balance weight at the back. The drying element is not presented. As the shrinkage takes place, the pen, as stated, moves horizontally, and as drying takes place, the pen moves vertically.

In interpreting the graph produced, the number of millimeters of vertical movement is divided by 2.6 to give grams of water lost and the horizontal movement is divided by 6 to get absolute shrinkage, or by 12 to get per cent shrinkage, as the bar is 200 mm. long. At any point on the graph the corelative water loss and shrinkage may be determined.

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CERAMIC ABSTRACTS[1]

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Vol. 11 **January, 1932** **No. 1**

Abrasives

Centerless grinding. Anon. *Abrasive Ind.*, **12** [11], 21–22 (1931).—Centerless grinding differs from the center type of cylindrical grinding in that the work is not swung between centers at its axis of rotation. Three principal work-determining elements of the usual centerless grinding machine are the grinding wheel, the regulating wheel, and the work rest. E.P.R.

Grinding motor parts to close tolerance. Cadillac Motor Car Co. *Abrasive Ind.*, **12** [11], 11–14 (1931).—The shafts are turned in special camshaft lathes. The set-up for grinding the cams is a special unit developed for the work. It is fitted with an alumina wheel 18 in. in diameter, with a 3/4-in. face, 50 grit, shellac bond. See also *Ceram. Abs.*, **10** [8], 533 (1931). E.P.R.

Manufacture of rolled plate. XIV. Ernst Lutz. *Glass Ind.*, **12** [11], 222–25 (1931).—The grinding machine and its auxiliaries are discussed. The general make-up of the grinding disk proper is described and the arrangement of the iron grinding bars on the disk in order to provide for the greatest compact grinding surface is discussed. The relative merits of different shapes of grinding bars are compared and the mechanical operation of the grinding machine, gearing, and motors used is described. Illustrated. For Part XIII see *Ceram. Abs.*, **10** [12], 835 (1931). E.J.V.

Grinder with horizontal spindle. Churchill Machine Tool Co., Ltd. *Abrasive Ind.*, **12** [11], 29–30 (1931).—The wheel head design and drive of this horizontal spindle machine are new. Described and illustrated. E.P.R.

Multi-V belted grinders. Hammond Machinery Builders. *Brass World*, **27** [10], 217 (1931).—Power is transmitted from the motor to the spindle by means of multi-V belts. The motor is mounted in the rear of the pedestal. E.P.R.

Heavy-duty snagging grinder. Hisey-Wolf Machine Co. *Metal Cleaning & Finishing*, **3** [10], 842 (1931).—This grinder affords independent speed control for each wheel. The machine is manufactured for 20-, 24-, and 30-in. grinding wheels. Another feature is an automatic belt tension adjustment which eliminates motor adjustment. Illustrated. E.J.V.

Surface grinder and polisher. Ingersoll-Rand Co. *Brass World*, **27** [10], 220 (1931).—A new surface grinding machine adaptable to high-production grinding, sanding, polishing, buffing, and wire-brushing operations can be fitted with a grinding wheel, sanding head, or wire brush. E.P.R.

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.
The bold-face number following the journal name is the volume, the issue number is in brackets followed by the page numbers, then the year in parentheses.

Polishing hard carbides on diamond lathe. W. A. WISSLER. *Metal Prog.*, **19** [4], 49–51 (1931).—The procedure for polishing tungsten carbide is similar to that used on diamonds. The sample is placed in a "dopp" of copper or bronze and the dopp is filled with a low-melting alloy. Samples are prepared for the diamond lathe by grinding with silicon carbide wheels having a soft bond and running at low speed. Final polishing is done with a wheel of No. 9 diamond dust mixed with olive oil. E.P.R.

Adjustable diamond mounting. MENDES CUTTING FACTORIES, INC. *Abrasive Ind.*, **12** [11], 30 (1931).—The adjustable grinding wheel truing diamond mounting is described and illustrated. E.P.R.

Honing cylinder blocks. BARNES DRILL CO. *Abrasive Ind.*, **12** [11], 31 (1931).—An all-geared, hydraulically operated honing machine is designed especially for the economical finishing of automotive engine cylinder blocks. Illustrated. See also *Ceram. Abs.*, **9** [5], 324 (1930). E.P.R.

Finishing auto piston reliefs. CINCINNATI GRINDERS, INC. *Abrasive Ind.*, **12** [11], 30–31 (1931).—A modified centerless grinder for finishing reliefs at a fast production rate has been developed. E.P.R.

Steel mill roll finishing. H. J. WILLS. *Abrasive Ind.*, **12** [11], 15–16 (1931).—Various phases of steel mill roll grinding are discussed in detail. E.P.R.

PATENTS

Art of grinding hobs. JOHN EDGAR. U. S. 18,246, Nov. 10, 1931 (reissue).

Hob-grinding machine. JOHN EDGAR. U. S. 18,247, Nov. 10, 1931 (reissue).

Grinding external cylindrical surfaces. MARSDEN C. HUTTO. U. S. 1,827,789, Oct. 20, 1931. A grinding device comprising a body provided with a longitudinal passage for the reception of the article to be ground, a plurality of abrading members arranged in an annular row around the passage and having abrading surfaces at their inner sides adapted to engage the periphery of theart icles, a controlling device cooperating with the abrading members and having parts arranged externally of the body and adjustably rigid relative to each other to positively fix the general limit of expansion of the members, and spring means for yieldingly drawing the abrading members laterally outward comprising relatively movable projections arranged at opposite ends of the abrading members, relatively fixed projections arranged at opposite ends of the body and alternating with the movable projections at the respective ends of the abrasive members, and springs each engaging with the projections at the corresponding ends of the abrasive members and the body.

Truing mechanism for grinding wheels. WILLIAM LE ROY BRYANT. U. S. 1,827,967, Oct. 20, 1931. A grinding machine comprising a bed, a grinding wheel thereon, a work carrier, a dressing tool carrier pivoted to the bed and swingable to present a dressing tool against the periphery of the wheel, and means for engaging the free end of the tool carrier with the work carrier to hold the tool in operative position against the wheel.

Method and tool for lapping or honing. FREDERICK W. ROEBBEL AND HARRY E. ROGERS. U. S. 1,828,074, Oct. 20, 1931. In a tool, a body, a groove in the side of the body, the bottom of the groove being inclined from the axis of the body, a lapping or honing element mounted in the groove and slidable lengthwise and projecting beyond the periphery of the body, a sleeve fitting over the body and having a slot for receiving the element, and means connected to the sleeve for moving the element lengthwise of the groove while the lapping or honing operation is being performed.

Grinding machine. WILLIAM J. BAUMBERGER. U. S. 1,828,384, Oct. 20, 1931. In an orbital grinding machine, a rotatable head, a spindle member eccentrically and rotatably mounted in the head and adapted to eccentrically support a spindle, means

for driving the head, a gear coaxial with the head and rotatably mounted thereon, a gear fixed to the spindle-carrying member, reduction gearing carried by the rotatable head and forming a driving connection between the gears, and means for causing the first-mentioned gear to turn with respect to the head to turn the spindle-carrying member in the head.

Grinding machine. CLEMENT BOOTH. U. S. 1,828,387, Oct. 20, 1931. In a device, the combination with a pair of opposed grinding and regulating wheels forming a grinding throat therebetween and a work-rest blade within the throat supporting the work for simultaneous engagement with the wheels, of means for placing the work on the work-rest blade and removing it therefrom comprising a vertically shiftable carrier, a pair of arms carried by the carrier having fingers at one end thereof for supporting the work during movement toward and from the work-rest blade, and means for effecting movement of the carrier.

Work-supporting mechanism for grinding machines. WARREN F. FRASER. U. S. 1,828,530, Oct. 20, 1931. In a machine for operating on metal articles of work having bored ends, the combination of two rotatable work-supporting members having portions adapted to enter the holes in opposite ends of an article of work and to center the article, one of the members being tapered to fit tightly in the hole and drive the work, mechanism for rotating the latter member, means for moving the driving member axially toward and from the other work-supporting member to engage and disengage the work, strippers for releasing the work from both of the members, parts supporting one of the strippers for operative movement relatively to its coöperating work-supporting member, and connections between the means and the latter stripper for operating it.

Buffer or grinder. WILLIAM A. MARSCHKE. U. S. 1,828,540, Oct. 20, 1931. The combination of a drive shaft, a driven shaft, a driven clutch member on the driven shaft and rotatable therewith, a driving clutch member on the drive shaft, a stationary member, the driven clutch member being axially slidable along the dri n shaft to engage either the stationary member or the driving clutch member, sp ng means normally controlling the driven clutch member as to its engagement with the driving clutch member, the driven clutch member being provided with a hub having an annular groove, a slidable shifting yoke having a portion lying in the groove, that portion of the shifting yoke which lies in the groove being less in thickness than the width of the groove, an abutment for limiting the movement of the yoke, spring means acting on the yoke to hold it against the abutment, the abutment being located so that when the yoke engages it the portion of the yoke which lies in the peripheral groove in the hub will be free from contact with the walls of the groove, and means for shifting the yoke.

Grinding simultaneously two opposed surfaces of articles of prismatic or other shape, especially nuts. AUGUST JOPP. U. S. 1,828,663, Oct. 20, 1931. A machine comprising a series of grinding wheels arranged in a row with their axes parallel and at an obtuse angle to the line of advance of articles to be ground, the wheels each having a conical grinding surface, the wheels having concentric portions of different degrees of fineness, and a tube through which the articles pass having openings opposite the wheels enabling grinding engagement of the wheels with the articles below the axes of the wheels so that the wheels will feed the articles, and having twisted portions between the wheels whereby the articles will be turned on their axes as they pass through the tube from one pair of wheels to another.

Combination dressing and grinding wheel. ROLAND P. PLACE. U. S. 1,829,057, Oct. 27, 1931. A combination dressing and grinding tool comprising a plurality of spaced apart, hardened, cutter disks and an abrading material filling the interstices between the cutter disks.

Valve grinding refacing and reseating device. LOUIS A. PRESTEK. U. S. 1,829,059,

Oct. 27, 1931. In an apparatus, a tool arbor shaft adapted for the reception of different tools, mechanism for imparting rotary reciprocatory movement to the shaft, means whereby the shaft is momentarily elevated during such rotary reciprocatory movement, and means whereby the rotary reciprocatory movement may be converted into a unidirectional drive for the shaft.

Portable grinding and polishing device. EDWARD S. ERICKSON. U. S. 1,829,440, Oct. 27, 1931. In a device, a portable rigid longitudinal frame, spaced pulleys carried thereby movable relative to the frame and movable toward and away from each other, elements on the frame movably supporting the pulleys, an abrasive belt on the pulleys having a freely unbacked run therebetween, yieldable means for tensioning the belt, and manually controlled means for moving the pulleys relative to the frame and toward each other.

Making abrasive product. LEWIS E. SAUNDERS, LOWELL H. MILLIGAN, AND MILTON F. BEECHER. U. S. 1,829,761, Nov. 3, 1931. A grinding wheel comprising crystalline alumina grains bonded by a substance which has substantially the same coefficient of expansion as that of crystalline alumina below the annealing range of temperatures and which is stable during normal usage.

Grinding fixture for thread-cutting chasers. ALBERT F. BREITENSTEIN. U. S. 1,830,189, Nov. 3, 1931. A grinding fixture for thread-cutting chasers having a disk-shaped head swiveled to turn in a horizontal plane, a horizontal longitudinally adjustable carrier bar extending diametrically over and carried by the head and adapted to be axially rocked in a vertical plane, and a chaser holder located above and carried by the bar.

Grinding machine. WALDO J. GUILD AND ALFRED P. BURNS. U. S. 1,830,358, Nov. 3, 1931. In a grinding machine, a grinding wheel, workholding means, a table or carriage carrying one of the parts, cross-feeding means to feed the work piece and grinding wheel in cutting relation, a dressing device, means to procure a limited reciprocation of the carriage, automatic means to reduce the rate of cross feed between the grinding wheel and work piece before the latter reaches finished size, and means for thereafter interrupting the grinding operation by extending the amplitude of the reciprocation to dress and true the grinding wheel by passing it by the dressing device, thereby to subject the grinding wheel to dressing only after the excessive wheel pressure due to preliminary rough grinding has been relieved.

Brake-drum grinder. AMOS P. STEINER. U. S. 1,830,723, Nov. 3, 1931. A grinding machine having a shaft carrying a pair of grinding wheels, means for moving the grinding-wheel support into and out of operative grinding position, means for moving the work support into and out of grinding position, means for rotating the work support, and a single control means for operating the grinding wheel support and the work support and for rotating the work support.

Abrasive article. MINER L. HARTMANN. U. S. 1,830,757, Nov. 10, 1931. A self-dressing abrasive article whose abrading surface is adapted to be moved relatively to any article being ground, the article comprising a bonded mass of abrasive grains which have a hardness of at least 9 on Mohs' scale, together with friable grains less hard than the abrasive grains and of a hardness less than 9 on Mohs' scale but sufficiently hard to break out of the mass without glazing the surface of the abrasive article.

Grinding gears. FREDERICK E. MCMULLEN, JAMES E. GLEASON, AND ARTHUR L. STEWART. U. S. 1,830,952, Nov. 10, 1931. The method of grinding the side tooth surfaces of a longitudinally curved tooth gear which consists in rotating a grinding wheel having an active surface of curved profile on its axis while reciprocating the wheel in a longitudinally curved path across the face of the gear to be ground.

Grinding gears. HERBERT EDGAR TAYLOR. U. S. 1,830,971, Nov. 10, 1931. The

method of grinding the side tooth surfaces of a longitudinally curved tooth gear which consists in rotating a grinding wheel on its axis while moving it in a longitudinally curved path across the face of the gear to be ground and simultaneously imparting a relative rolling motion between the wheel and gear.

Roll-grinding machine. HARRISON R. WILLIAMS. U. S. 1,831,085, Nov. 10, 1931. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in a substantially upright position, a grinder, and a grinder guide extending parallel to the axis of rotation of the roll.

Grinding. GEORGE T. HUXFORD AND FRANK E. STRATTON. U. S. 1,831,353, Nov. 10, 1931. In a grinding machine, a grinding element, a rotatable work-holding center mounted opposite a portion of the grinding surface of the grinding element, a plurality of releasable work-holding chucks mounted on the center adapted to hold work in grinding relationship to the grinding element, means to rotate the grinding element, means to rotate the work-holding center, means to rotate the chucks, means to relatively tilt the grinding element and work, and means to lock the means in relative tilted position.

Portable grinding machine. WILLIAM J. IRWIN. U. S. 1,831,863, Nov. 17, 1931. A portable grinding machine comprising a frame, a grinding wheel rotatably mounted thereon, means on the frame for rotating the wheel, a work rest, a support for the rest having a slot, means whereby the support may be adjusted to move the rest toward and from the wheel, a clamping member slidable in the slot which pivotally holds the rest in an adjusted angular position, and means indicating two grinding positions for the rest, the slot being inclined at an angle to a horizontal plane and having two limiting positions which serve to so locate the clamping member that when the rest is in either of the indicated grinding positions, it will be at approximately the same distance from the wheel and will hold the work in substantially the same position relative to the line of cutting action.

Truing and dressing grinding wheels. FERDINAND J. HOHNHORST. U. S. 1,831,913, Nov. 17, 1931. The combination with an end-contact rotary abrading nib, of a chuck provided with a socket in which the rotary abrading nib is received, an extractor plate in the socket, means for urging the extractor plate outwardly for releasing the abrading nib, and means retaining the extractor plate in the socket, the rotary abrading nib having an axial bore adapted to have a tool insertable inwardly thereinto for coaction with the means for urging the extractor plate outwardly for releasing the abrading nib.

Lapping machine. HERBERT S. INDGE AND SYDNEY PLAYER. U. S. 1,831,958, Nov. 17, 1931. A lapping machine comprising two opposed laps, a work cage therebetween arranged to hold a multiplicity of work pieces in peripherally spaced lapping engagement therewith, the parts being relatively movable to lap the work, means for moving the laps relatively toward and from each other, adjustable mechanism for impressing a predetermined pressure upon the work by the laps, and manually operated means for varying the pressure.

Grinding machine. JOHN E. PETERSON. U. S. 1,831,970, Nov. 17, 1931. In combination, supporting means, a grinding member, and a carriage member having a pair of spaced projections and means spanning the projections to engage the jaw to be ground in its pivoting hole when interposed between the projections and thereby confine it against movement except around the axis of the hole and against the grinding member and also having means, removed from the second-named means, to clamp the jaw as thus moved, one of the members being movable past the other.

Internal grinding machine. ALDEN M. DRAKE. U. S. 1,832,104, Nov. 17, 1931. In a grinding machine, a wheel head and a grinding wheel thereon, the head having a hollow annular portion, a closure therefor providing a plurality of axially extending

nozzles communicating with the hollow annular portion, a spindle by which the work is supported, means to supply water to the annular member whereby jets of water will be directed axially of the wheel head, and on the wheel axially thereof to cool the wheel, additional means to supply water from substantially the opposite direction, and means to direct the additional supply on the work substantially axially thereof to cool the work.

Abrasive article. DUANE E. WEBSTER. U. S. 1,832,515, Nov. 17, 1931. An abrasive article comprising a resinoid body, an abrasive member of resin-bonded abrasive grains, and a layer of cementitious organic material between and integrally uniting the bonded abrasive member with the resinoid body.

Making an abrasive disk. ALBERT J. DOERMANN. U. S. 1,832,535, Nov. 17, 1931. The method of making an abrasive disk bonded with a corrosive cement united to a metallic backing, which consists in first coating the backing with a corrosion-resistant cement containing abrasive articles to which the bond of the disk will adhere, and then molding the abrasive disk upon the coated backing.

Rotatable grinding or honing device. ARTHUR M. JOHNSON. U. S. 1,832,635, Nov. 17, 1931. A device comprising, in combination, a body member provided with a plurality of circumferentially spaced longitudinally radially formed grooves, cams mounted at the respective bottoms of each of the grooves, a plurality of radially movable abrading stones mounted in the grooves on the body member and carried by the cams but being formed separately therefrom, means movable longitudinally with respect to the body member for operating the cams for moving the stones radially with respect to the body member, means for holding the abrading stones in contact with the supporting surfaces of the cam members, and means for adjusting the longitudinally movable means with respect to the cams.

Internal centerless grinding machines. CINCINNATI GRINDERS, INC. Brit. 357,621, Oct. 7, 1931.

Grinding or abrading machines. CINCINNATI GRINDERS, INC. Brit. 357,622, Oct. 7, 1931, and Brit. 359,383, Nov. 4, 1931.

Centerless grinding machines. CINCINNATI GRINDERS, INC. Brit. 358,108, Oct. 14, 1931.

Art and Archaeology

New specialties in china and glass. ANON. *Pottery Glass & Brass Salesman*, **44** [1], 11 (1931).—A large number of new specialties in china and glass are being displayed by the following companies: (1) Duncan & Miller Glass Co., (2) Groh, Newland, & Schneeloch, (3) Liberty Works, (4) Anchor Mfg. Co., and (5) Geo. C. Kindt & Co. *Ibid.*, **44** [2], 13 (1931).—(1) Steubenville Pottery Co., (2) Roseville Pottery Co., (3) Metropolitan Pottery Co., and (4) A. H. Heisey & Co. *Ibid.*, **44** [3], 12 (1931).—(1) W. S. George Pottery Co., (2) Skinner-Hill Co., (3) Justin Tharaud, Inc., (4) Taylor, Smith, & Taylor Co., and (5) J. J. Hines, Inc. *Ibid.*, **44** [4], 12 (1931).—Wm. S. Pitcairn Corp. *Ibid.*, **44** [5], 11 (1931).—(1) A. J. Fondeville & Co., (2) Fred C. Reimer Co., and (3) Zane Pottery Co. *Ibid.*, **44** [6], 12 (1931).—(1) Josiah Wedgwood & Sons, Inc., of America, (2) Edmondson Warrin, Inc., (3) Geo. Borgfeldt & Co., and (4) Haruta & Co. *Ibid.*, **44** [7], 29–30 (1931).—(1) Dunbar Glass Corp., (2) Rowland & Marsellus Co., (3) Morimura Bros., (4) Hocking Factories, (5) Heinrich & Winterling, (6) Duncan & Miller Glass Co., (7) American Chinaware Corp., (8) Seneca Glass Co., and (9) Paul A. Straub & Co. *Ibid.*, **44** [8], 12 (1931).—(1) Percy Leland, Inc., (2) Imperial Glass Corp., (3) Neuwirth Importing Co., and (4) Eagle Mfg. Co. *Ibid.*, **44** [9], 11

(1931).—(1) Nagoya Seitosho, Ltd., and (2) Fulper Pottery. *Ibid.*, **44** [10], 11 (1931).—(1) J. H. Venon, Inc., (2) Meakin & Ridgway & Co., and (3) H. C. Fry Glass Co. E.P.R.

Gifts of pottery and glassware. ANON. *Pottery Gaz.*, **56** [652], 1410–12 (1931).—Some of the many lines of ware that pottery and glass manufacturers can offer as possible gift merchandise are illustrated and briefly described. E.J.V.

Unusual plate etching. A. H. HEISEY & CO. *Crockery & Glass Jour.*, **109** [9], 43 (1931).—The etching consists of vertical lines of figures in square-footed stemware both with long and short stems. It is also offered in a complete table-service line. E.P.R.

Development of ceramic art. L. HEIN. *Sprechsaal*, **64** [42], 771–72 (1931). W.M.C.

Laboratories for research on works of art. A. P. LAURIE. *London Studio*, **462**, 198 (1931).—The Fogg Museum at Harvard, the Louvre in Paris, and the British Museum have been pioneers in bringing scientific methods to bear on problems connected with art. H.H.S.

Saracenic art glassware. ANON. *Crockery & Glass Jour.*, **109** [10], 27 (1931).—Inspiration for Saracenic art glassware came from the hand-wrought glass made by Saracen workers of the 13th Century. Old Morgantown's adaptation of Saracenic art glassware is made in black and in Ritz blue, ornamented with gold applied in a unique veined design. E.P.R.

Athenian vase with "The Return of Persephone." G. M. A. RICHTER. *Bull. Met. Mus. Art.*, **26** [10], 245–48 (1931).—An important Athenian red-figured vase acquired by the Museum is a finely proportioned bell-krater or mixing bowl, with a scene of the return of Persephone. The scenes are contemporary with the Parthenon sculptures, 440 B.C. A.A.A.

Collection of Buddhist votive tablets. ALAN PRIEST. *Bull. Met. Mus. Art*, **26** [9], 209–13 (1931).—The Museum has recently acquired the beginning of a collection of votive clay images and tablets which should prove valuable to students of Chinese art. They are reproductions of pieces of large sculpture and in many instances are dated, at least by dynasty. A.A.A.

Exhibition of goblet. ANON. *Amer. Glass Rev.*, **51** [3], 12 (1931).—The goblet of St. Elizabeth of Thuringia is of smoked glass adorned with Oriental designs and is believed to be of Egyptian origin. E.P.R.

Pottery figures of the T'ang dynasty. WILLIAM KING. *Studio*, **99** [411], 26–28 (1931).—Descriptions and illustrations of grave figures, glazed and unglazed, of the T'ang dynasty are given. E.B.H.

A rhyton in the Brygan manner. DANIEL CATTON RICH. *Studio*, **99** [411], 20–74 (1931).—A rhyton is a type of Attic vase, a drinking horn, of the 5th Century B.C. modeled in the shape of an animal head, usually a horse, and decorated with Dionysian motifs. Fine examples are found in the Chicago Art Institute and the Boston Museum of Fine Arts. Illustrated. E.B.H.

Progress of archaeology. ANON. *Discovery*, **12**, 293–94 (1931).—The results of excavations proceeding in Nineveh, Middle Egypt, Palestine, S. Africa, and Roman sites in Britain are briefly reviewed. H.H.S.

New light on aboriginal America. T. GANN. *Illus. London News*, **179**, 330–31 (1931).—The Mexican government's excavations at Calixtlahuaca and Teotihuacan are described. H.H.S.

Cliff-dwellers of Colorado. G. WOODBURY. *Discovery*, **12**, 278–82 (1931).—The pottery of the Mesa Verde is plentiful and characteristic. Illustrated. H.H.S.

New treasures from the Agora at Athens. T. L. SHEAR. *Illus. London News*,

179, 337–38 (1931).—The American School's work, undertaken by invitation of the Greek authorities, is described. The purchase and demolition of 600 modern houses was involved. H.H.S.

Tell-el-Amarna finds. J. D. S. PENDLEBURY. *Illus. London News*, **179**, 366–67 (1931).—Photographs are presented which illustrate the discoveries made by the Egypt Exploration Society at the short-lived capitol of the Pharaoh, Akhenaten. H.H.S.

BOOKS

History and Ideals of American Art. EUGEN NEUHAUS. Stanford Univ. Press, 1931. Price $6.50. Reviewed in *Connoisseur*, **88**, 186 (1931). H.H.S.

Modern Glass. GUILLAUME JANNEAU. 200 plates. The Studio, Ltd., London, 1931. Price 30s. H.H.S.

Chinese Ceramics in Private Collections. R. L. HOBSON, B. RACKHAM, AND W. KING. xxii + 201 pp., 32 color plates, 361 reproductions. Halton and Truscott Smith, London, 1931. Price 5 guineas. Reviewed in *Times Lit. Supp.*, **30**, 620 (1931).—The seven collections dealt with are those of Bloxam, Harris, Alexander, Holt, Oppenheim, Raphael, and Russell. H.H.S.

The Stone Age Cultures of Kenya Colony. L. S. B. LEAKEY. xiii + 283 pp. Cambridge Univ. Press, 1931. Price 25s. Reviewed in *Times Lit. Supp.*, **30**, 627 (1931). H.H.S.

Greek and Syrian Miniatures in Jerusalem. W. H. P. HATCH. xiii + 136 pp., 72 plates. Mediæval Academy of America, Cambridge, Mass., 1931. Price $12.00. Reviewed in *Times Lit. Supp.*, **30**, 665 (1931).—Seventy-one miniatures of the second golden age of Byzantine art (867 to 1204 A.D.) are described and reproduced. H.H.S.

PATENTS

Design for bottle. JOSEPH C. EGIZIO. U. S. 85,369, Oct. 20, 1931. EDWIN W. FUERST. U. S. 85,379, Oct. 20, 1931. GEORGE MCPHEE. U. S. 85,486, Nov. 3, 1931. ALBERT C. MEYER. U. S. 85,487, Nov. 3, 1931. CHARLES H. OESTREICH. U. S. 85,490, Nov. 3, 1931.

Design for bowl, etc. FREDERICK J. PETERS. U. S. 85,392, Oct. 20, 1931.

Design for bathroom paper or sponge holder, etc. STEPHEN D. BAKER. U. S. 85,508 and 85,509, Nov. 10, 1931.

Design for cup, etc. GEORGE WESP. U. S. 85,563, Nov. 10, 1931.

Design for cover for water-closet flush tank. BERT O. TILDEN. U. S. 85,606, Nov. 17, 1931.

Design for goblet, etc. WILBER L. ORME. U. S. 85,388 and 85,389, Oct. 20, 1931. JESS CLAIR KELLY. U. S. 85,528, Nov. 10, 1931.

Design for lighting-fixture bowl, etc. NICHOLAS KOPP. U. S. 85,384, Oct. 20, 1931.

Design for combination soap holder and grab rail. STEPHEN D. BAKER. U. S. 85,459, Nov. 3, 1931.

Design for pitcher, etc. FREDERICK J. PETERS. U. S. 85,393, Oct. 20, 1931.

Design for range. JOSEPH P. ROESCH. U. S. 85,396, Oct. 20, 1931. JEROME C. BOYLAN. U. S. 85,463, Nov. 3, 1931. ARTHUR STOCKSTROM. U. S. 85,497, Nov. 3, 1931.

Design for plate. ANGELO C. SCAVULLO. U. S. 85,398 to 85,400, Oct. 20, 1931.

Design for spout. GEORGE SAKIER. U. S. 85,397, Oct. 20, 1931.

Design for glass panel for luminairs. ERNEST STROUD. U. S. 85,401 and 85,402, Oct. 20, 1931.

Design for stove. EMMETT F. KENNEDY. U. S. 85,383, Oct. 20, 1931. WALTER F. ROGERS. U. S. 85,495, Nov. 3, 1931. JOHN W. SPEAKER. U. S. 85,496, Nov. 3, 1931.

Design for perfume bottle, etc. ROBERT BETTS. U. S. 85,363, Oct. 20, 1931.

Design for wash fountain. DAVID H. EBINGER. U. S. 85,516, Nov. 10, 1931.

Design for water-closet flush tank. BERT O. TILDEN. U. S. 85,560, Nov. 10, 1931. GEORGE BRAIN. U. S. 85,364, Oct. 20, 1931.

Design for jar. EDWIN W. FUERST. U. S. 85,471, Nov. 3, 1931.

Design for vase. OLBERT C. NOBLE. U. S. 85,594, Nov. 17, 1931.

Etching portraits on mirrors. PETER LOPEZ. U. S. 1,832,716, Nov. 17, 1931. The process of preparing an etched image representation having a mirrored background, which comprises the steps of preparing an opaque multitone pattern of the image representation, disposing the pattern against one face of a pane of glass, applying to the other face of the pane a layer of a fluid medium resistant to a chemical compound capable of etching glass to cover that portion of the pane not covered by the pattern, applying a boundary beading to the last-mentioned face of the pane, pouring onto the face of the pane, within the bounds of the pattern, dilute hydrofluoric acid to effect initial etching of the face of the pane, removing the acid and washing the etched surface with water, pouring onto the surface a mixture of dilute hydrofluoric acid and sodium carbonate and permitting the mixture to remain until the pane surface is further etched, removing the mixture, pouring water onto the etched surface and permitting the water to remain for a period of approximately one-half hour, disposing the etched pane over the pattern and applying to the face of that portion of the pane which is over the darkest tone portions of the area of the pattern a layer of the resistant medium, pouring dilute hydrofluoric acid onto the face of the pane and permitting the acid to remain a few minutes, and then repeatedly carrying out the four last-described steps in the order stated, and pursuing these steps in the successive treatment of different portions of the face of the pane over successively lighter tone portions of the area of the pattern.

Cement, Lime, and Plaster

Hardening of Portland cement. F. F. TIPPMANN. *Zement*, **19** [52], 1225–34 (1930); *Chim. & Ind.*, **25** [6], 1432 (1931).—The hydrolysis of silicates of calcium of clinker is always complete no matter what quantity of water is used; hydrated lime and colloidal silica are formed. The form of the products of hydrolysis, however, is not the same in the presence of normal quantities of water or excess water. In the last case, needles of hydrate of lime are observed which do not appear with a normal consistency of mortar. Neither crystals nor colloidal particles of hydrosilicate of calcium are formed during drying. The total hydrate of hydrolyzed lime exists in the hardened cement in crystalline form but the crystals are irregular and of lamellar structure. The swelling of cement is not due to the hydrate of crystallized lime or lime which can be crystallized but to the amorphous hydrate of lime. The phenomenon of hardening of Portland cement depends on the double action of colloidal silica and of the crystalline hydrated lime, an essential constituent of a hardened cement. A too great crystallization of the hydrate of lime also causes a swelling because the action of the silica gel becomes insufficient. A method of microscopical observation worked out by T. permits the observation of the hardening of Portland cement and confirms these assertions. M.V.K.

Essential properties of Portland cement and their consequences. ANGELO LILI. *Pit & Quarry*, **23** [1], 52–54 (1931).—Pure Portland cements of high quality should have certain properties, *viz.*, (1) constancy of volume, (2) minimum quantity of mixing water, (3) slow setting during the first 24 hr., (4) minimum shrinkage, (5) high strength at 7 days, with considerable increase from 7 to 28 days, (6) highest possible ratio be-

tween the tensile and compressive strengths, (7) highest possible ratio between the strengths obtained in the concrete and those obtained in the standard mortar, and (8) high density. If R' and R'' are the strengths obtained after 7 and 28 days, respectively, and a the coefficient of increase, then $R'' \geq R' \cdot a$. If T' and T'', C' and C'' are the tensile and compressive strengths, respectively, after 7 and 28 days, the following formula is obtained: index of quality $J = \frac{C''}{C'} \times \frac{T' + T''}{C' + C''}$. If J is multiplied by the compressive strength of the concrete after 7 days, K', $J \times K' = J_r$ is obtained, which is the strength index of the cement in question. The index of quality, J, can be the same for different cements. E.P.R.

Hydraulic and white magnesia cement. A. CH. VOURNAZOS. *Z. anorg. allgem. Chem.*, **200** [3], 237–44 (1931).—V. describes a cement made from Santorin earth (an amorphous form of silica) and burned magnesite. Some strength tests are included. A white cement made from artificially prepared silica and a naturally occurring magnesite, "Leukolithos," is also described. L.T.B.

Manufacture of hydraulic cement. JOSEPH ROSSMAN. *Rock Prod.*, **34** [23], 46–50 (1931).—R. has reviewed and briefly abstracted the U. S. patents relating to the manufacture of Portland and other hydraulic cements. With the exception of one patent noted in 1837 and four in the decade, 1870 to 1880, practically all of the 102 patents listed were granted during the past 50 years. W.W.M.

Anhydrite cement. P. P. BUDNIKOFF. *Pit & Quarry*, **23** [2], 57–58 (1931); see also *Ceram. Abs.*, **10** [9], 626 (1931). E.P.R.

Transformation of gypsum semihydrate into anhydrate at atmospheric pressure. R. NACKEN AND K. FILL. *Tonind.-Ztg.*, **55** [86], 1194–96 (1931).—Two hydrates of calcium sulphate are distinguished: gypsum and semihydrate. The dehydration of the semihydrate may be done at constant temperature. With atmospheric pressure and dry air, gypsum may be dehydrated at a temperature of only 20°C. This process takes a long time. Further subjects dealt with are the system $CaSO_4$–H_2O and the vapor tension for the transition of the semihydrate to anhydrate. See also *Ceram. Abs.*, **10** [11], 755 (1931). W.M.C.

Rate of calcination of gypsum. WALLACE C. RIDDELL. *Rock Prod.*, **34** [23], 64–65 (1931).—R. cites previous workers on the temperature at which gypsum loses its combined water. A number of experiments were performed on various samples of gypsum to determine whether the rate of penetration of the zone of calcination was constant for any given temperature over the complete period of calcination. This rate varies from about 0.25 cm. per hour at 150°C to 3.0 cm. per hour at 300°C. The temperature of decomposition of gypsum was found, for practical purposes, to be approximately 128°C. Graphical and tabular data are given. See also *Ceram. Abs.*, **10** [3], 172 (1931). W.W.M.

X-ray studies of basic magnesium chlorides. Studies of cements containing magnesium oxide. W. FEITKNECHT. *Helvetica Chim. Acta*, **13** [6], 1380–89 (1930); *Chim. & Ind.*, **25** [3], 633 (1931).—Through the study of basic salts of magnesium by the Debye-Scherrer X-ray method, it may be ascertained whether the hydroxide and salt are a simple mechanical mixture or are chemically combined. These researches confirm and complete the theories already established on the hardening of Sorel cements. The results are as follows: (1) The total quantity of hydroxide is chemically combined and not physically mixed in all products in which the quantity of hydroxide is between 2, 3, and 7 mol. of $Mg(OH)_2$ per mol. of $MgCl_2$. (2) Various quantities of hydroxide correspond to different crystals of the same structure. Some of these crystalline variations may contain different quantities of magnesium hydroxide with-

out any change in structure. (3) Magnesium hydroxide is completely combined with the chloride of a Sorel cement whose hardening is completed. (4) During hardening, the oxide changes directly into basic salt. (5) Several crystalline varieties may be formed when the ratio of constituents varies and its varieties are similar to those corresponding to isolated basic chlorides. (6) The crystals formed can be subsequently transformed into others in conformity with the equilibrium when the quantity of the chloride is high. (7) The basic chlorides resulting from a double decomposition with a chloride solution change into a crystalline variety less rich in water with a forced drying. This transformation decreases resistance in the case of Sorel cements. M.V.K.

New materials of high resistance to acids. P. N. GRIGORIEV AND Y. Y. SILVESTROVITCH. *Jour. Prikladnoi Khim.*, **3** [8], 1155–58 (1931); *Chim. & Ind.*, **26** [3], 626 (1931).—Two products with a high resistance to acids were studied. The first, called "metal-cement," is composed of 70% sulphur, 5% graphite, and 20% Portland cement. By heating it to 100°, this product melts and adheres well to wood, brick, cement, and concrete. By heating in water, a partial dissolving of lime takes place, but this does not occur when cold. Portland cement can be replaced by clay to obtain a completely insoluble product. The second product is composed of 92% crushed quartz, 4% crystalline silicon, and 4% sodium fluosilicate. It is used in a mixture with soluble glass of 36 to 38 Bé ($Na_2O:SiO_2 = 1:2.8$). A thick paste is obtained which hardens after 30 or 40 min. It adheres well to wood, brick, cement, concrete, and metallic surfaces and resists acid well even when heated. The quartz can be replaced by sand or other substances containing much silica. The properties of this product are due to the action of fluosilicate on soluble glass: $SiF_4{\cdot}2NaF + 6H_2O + 2SiO_3Na_2 = 6NaF + 3Si(OH)_4$. It hardens more rapidly with an increase of its fluosilicate content. M.V.K.

PATENTS

Making porous cement. ERNEST WALTER. U. S. 1,829,381, Oct. 27, 1931. The process of making artificial stone which comprises mixing a plastic mass of cementitious material containing a small amount of free alkali with water and a small amount of liquid not soluble in water and which is more highly volatile than water, adding a small quantity of about one one-hundredth of the weight of cement of metallic powder that will produce hydrogen when mixed with water and the alkali in the cement at a temperature of less than 100°C, and heating the mass whereby the powder initiates a large number of gas bubbles and continued heating causes a further expansion by the volatile material.

Quick-hardening cement with high resistance. PAUL CADRÉ. U. S. 1,831,702, Nov. 10, 1931. A process for the production of cement which comprises separately drying, grinding, and cooling to normal temperatures substantially 80% blast-furnace slag, substantially 5% clinker, and substantially 15% calcium sulphate and mixing the ground substances.

Enamels

Enamel containing antimony for cooking utensils. HUGO KÜHL. *Glashütte*, **60** [48], 886–87 (1930); *Chim. & Ind.*, **25** [3], 645 (1931).—In most enamels antimony exists in its trivalent state which is the most stable. The pentavalent compounds are converted into trivalent compounds by the loss of oxygen during fritting (long firing or high temperatures). Three per cent solutions of tartaric acid or 4% acetic acid dissolve antimony from enamels in very small quantities. M.V.K.

Grinding fineness of enamels. ANON. *Glashütte*, **61** [1], 8–10 (1931); *Chim. & Ind.*, **25** [5], 1175 (1931).—An enamel of a constant and definite chemical composition may produce different results according to its degree of fineness. Enamel is classified in three categories based on its texture tested by hand: fine, half fine, and coarse. This method is very unreliable and is generally replaced by the sifting method. The method of sifting under a current of water is based on a good principle but is inconvenient in industry. M.V.K.

Enameled cast and annealed iron. R. R. FROELICH. *Giesserei-Ztg.*, **17** [40], 973–75 (1930); *Chim. & Ind.*, **25** [2], 365 (1931).—F. discusses different enameling methods used and points out the necessity of decarburizing and annealing the surface to be enameled. This can be done by the enamel itself if it contains oxidizing agents (zinc oxide and lead oxide). M.V.K.

Enameled tanks and their manufacture. ANON. *Ind. chim.*, **17** [203], 866 (1930).—A description is given of the manufacture, in the Pfaudler plants, of enameled tanks used for storing grape juice and wine. The steel tanks are coated twice with a special enamel at a temperature of 800 to 1000°. The enameling kiln is controlled continuously. The borax is tested before use and the feldspar and clay are tested for their chemical composition, capability of fusing, and resistance. The mixtures are fused carefully and controlled by an optical pyrometer. The vitrified enamel of a definite composition and fineness is prepared beforehand and is applied under exact pressure. M.V.K.

Manufacture of cast bathtubs and their enameling. L. VIELHABER. *Emaillewaren.-Ind.*, **8** [22], 25–26; [26], 32–33; [31], 35; [39], 49–51 (1931).—A detailed description is given of the casting and molding of bathtubs, devices used for their enameling, conditions for obtaining good enameled bathtubs, the preparation of enamels, and the processes of coating and firing. Four enamel batches are given. See also *Ceram. Abs.*, **10** [5], 330 (1931). M.V.K.

Enameling and its difficulties. JEMET. *Emaillewaren-Ind.*, **8** [39], 51 (1931).—J. discusses the difficulties in enameling and points out the necessity of research work in enamel works. M.V.K.

Continuous rotary pickling machine. N. RANSOHOFF, INC. *Metal Cleaning & Finishing*, **3** [10], 839 (1931).—A four-section rotary pickling machine capable of handling work up to 24 in. long is said to achieve a considerable saving in labor, time, and acid. The operation and construction of the machine are described. Illustrated. E.J.V.

Electrolytic cleaning and pickling. C. L. MANTELL. *Metal Cleaning & Finishing*, **3** [10], 785–89 (1931).—After summing up the more common cleaning and pickling methods it is pointed out that electric current can be employed advantageously in speeding up cleaning and pickling as well as in improving the quality of these operations. A detailed outline of the function of electrolytic cleaning and pickling baths is given. Illustrated. E.J.V.

Equipment for cleaning metal. X. R. W. MITCHELL. *Metal Cleaning & Finishing*, **3** [10], 793–96 (1931).—The various types of thermometers and temperature regulators used in cleaning operations are discussed. Illustrated. For Part IX see *Ceram. Abs.*, **10** [12], 827 (1931). E.J.V.

New sodium metasilicate. PHILADELPHIA QUARTZ CO. *Metal Cleaning & Finishing*, **3** [10], 840 (1931).—A purer sodium metasilicate for cleaning purposes in a new and better form known as Metso Crystals is announced. They are uniform grains, free from fine particles and dust, and are quickly and readily soluble in hot and cold water without residue. These metasilicate crystals are particularly efficient in the removal of grease. E.J.V.

Sheet enameling in 1832. L. VIELHABER. *Emaillewaren-Ind.*, **8** [39], 310–11 (1931).—V. describes the composition of sheet enamels, method used, and the process of coating. M.V.K.

Colored jewelry enamels for art school use. K. E. SMITH. *Sprechsaal*, **64** [43], 793 (1931); see also *Ceram. Abs.*, **10** [9], 621 (1931). W.M.C.

Enameling developments. P. PARRISH. *Chem. Age*, **25** [629], 58–63 (1931).—At the British Chemical Plant Exhibition held in London in July, T. & C. Clark of Wolverhampton showed enameled vessels of mild steel and Cannon Iron Foundries showed high-silica enameled vessels. H.H.S.

BOOKLET

Grease solvent. ROESSLER & HASSLACHER CHEMICAL CO. *Brass World*, **27** [10], 223 (1931); *Abrasive Ind.*, **12** [11], 26 (1931).—Properties and uses of Trichlorethylene, a grease solvent of the chemical formula, C_2HCl_3, are covered in a booklet recently issued by the Roessler & Hasslacher Chemical Co., New York. The product is a heavy, colorless, mobile liquid possessing a pleasant odor. The boiling point is 188°F. Trichlorethylene is an excellent solvent for oils, fats, greases, waxes, tars, gums, rubber, chewing gum, and many resins. It is not flammable or explosive nor does its vapor form combustible or explosive mixtures with air. Complete tables of vapor pressures, and chemical and physical constants are included in the booklet. E.P.R.

PATENTS

Wall tiling. GEORGE L. BENNETT. U. S. 1,829,976, Nov. 3, 1931. Wall tiling embodying therein a plurality of enameled sheet metal tile, each having converging side flanges, and a spring clip for permanent attachment to a wall structure engageable with a side flange of each tile.

Production of iron enamels. I. KREIDL. Brit. 358,886, Oct. 28, 1931.

Production of enamel coatings. INTERNATIONAL GENERAL ELECTRIC CO., INC. Brit. 359,758, Nov. 4, 1931.

Glass

Glass. V. ALBERT GRANGER. *Céram. Verrerie*, No. 823, pp. 21–25 (1931).—G. discusses (1) changes in viscosity of glass upon reheating, (2) deviations from the law of the variation of specific heat with increasing temperature, (3) coloration of glasses due to exposure to radiations, (4) electrical conductivity of glasses, and (5) methods for measuring viscosity. There is an excellent review of English, American, and German literature. **VI.** *Ibid.*, No. 824, pp. 61–66 (1931).—A discussion is given on the relation of composition to annealing temperatures and the relation of composition to fusibility. Data are given for density, resistance to tension and compression, elasticity, thermal endurance, specific heat, thermal expansion, and thermal conductivity in relation to the composition. **VII.** *Ibid.*, No. 825, pp. 137–40 (1931).—A discussion is given of the effect of composition on the index of refraction, transparency, and other optical properties of glasses. The volume changes taking place in thermometers with age are also discussed. For Parts I, II, III, and IV see *Ceram. Abs.*, **10** [6], 415 (1931). T.N.McV.

Theory of glass composition. BRUNNER. *Keram. Rund.*, **38** [22], 359 (1930); *Chim. & Ind.*, **25** [3], 639 (1931).—B. urges that the custom of expressing the quality of glass by its composition before melting be abandoned, *i.e.*, the custom of calculating all the raw materials in relation to the quantity of sand as the unit expressed generally

in 1000 kg. Only two possibilities exist: (1) the calculation by molecular percentage, or (2) calculation by weight. The latter is more suitable to modern glassworks. M.V.K.

Notes on journal articles on nature of glass. E. C. SULLIVAN. *Glass Ind.*, **12** [11], 215–20 (1931).—This review is an analysis of the bearing of recent researches on the causes of the peculiar properties of glass, a material which has refused hitherto to be explained in terms of any other materials. Recent data obtained are (1) a discontinuity in physical properties in the transition glass-liquid, (2) heat reaction in the transition glass-liquid, (3) equation of state for glass differing from that for liquid, and (4) X-ray evidence that some glasses consist largely of minute crystals. Work describing these findings is discussed. Illustrated. E.J.V.

Study of melting of sodium-alumina-borosilicate glass. M. A. BESBORODOV. *Ceramics & Glass*, **7** [6], 11–14 (1931).—B. describes the physical and chemical processes taking place during the fusing of a sodium-alumina-borosilicate glass. (1) The petrographic analysis showed that time and temperature of melting influence the degree of dissolving of quartz grains, and that the temperature has a greater influence than the time. (2) Quartz dissolves completely at 1200°C. (3) The index of refraction of the amorphous part of the melt decreases with increased temperature and increased degree of dissolving of quartz in the fusion. (4) The chemical analysis showed that CO_2 separates from the melt slowly up to 500°. From 500 to 700°, this separation goes on energetically, and at 800° the chemical analysis does not show any CO_2. B. concludes that the process of fusion and the formation of silicates is divided into two stages, chemical and physical. Silicates are first formed at temperatures below 800°. After this, a physical process of the solution of the remaining quartz grains in the fusion takes place. This process is completed at temperatures from 800 to 1100°. It can be assumed that simplest silicates are formed at the beginning (700 to 800°). With increased temperature, the stability of silicate formations increases; this is related to the formation of alumina and polysilicates. M.V.K.

Influence of chemical surface treatment on the hydrolytic properties of the glass surface. M. v. HIRSCHBERG AND F. H. ZSCHACKE. *Sprechsaal*, **64** [43], 790–93 (1931).—It is possible to change the surface alkalinity of glasses by a thermal treatment. Vapors of stannic chloride increase the amount of alkalis given off, whereas the amount is decreased considerably when nitrates are present. W.M.C.

Homogeneity of commercial glass. ANON. *Sprechsaal*, **64** [40], 735–37; [41], 753–56 (1931).—If a glass is placed behind a small opening through which solar light passes it is possible to draw many conclusions from the shadow of the glass, *e.g.*, homogeneity and difference in thickness of the wall. Blisters and bubbles in the glass may be recognized as they act like lenses for the incident rays. It is also possible to place a sheet of photographic paper behind the glass to be tested thus giving an objective and an easy way to test the glass. A number of photographs are given which show different faults encountered in hand- and machine-made products. Schematic diagrams are reproduced showing the melting of a glass in a furnace and the homogeneity of the melt. A list is given of the different faults which are considered as "allowed" or "not allowed" in glass products for different purposes. W.M.C.

Influence of boric acid on the fusibility of glasses and resistance to chemical agents. F. MÜLLER. *Glashütte*, **61** [13], 219–22 (1931); *Chim. & Ind.*, **26** [3], 632–33 (1931); *Céram. Verrerie*, pp. 325–28 (1931).—Boric acid in glass considerably increases the resistance of the glass to chemical action and affects its fusibility. The effect obtained depends on the manner in which the boric acid is introduced, the proportion of the acid introduced, and the constituent that it replaces. The replacement of sodium by 5% boric acid produces the best results and decreases the fusibility of the glass. The

replacement of silicic acid by 5% boric acid also shows the best results but increases the fusibility of the glass and with a higher content diminishes its qualities. This acid also affects the tenacity of glass, increasing it with an average addition, and decreasing it if too much is added. It decreases the coefficient of expansion in glass mainly in the case when it replaces soda, and affects the resistance to temperature variations, hardness for polishing, and cutting. M.V.K.

Decomposition of sodium chloride by steam in the presence of silicic acid. E. BERL AND H. STAUDINGER. *Z. angew. Chem.*, **43** [46], 1006–1009 (1930); *Chim. & Ind.*, **25** [3], 642 (1931).—These researches show how it is possible to replace sodium sulphate and sodium carbonate by chloride in the manufacture of glass. A mixture of salt and charcoal previously fused in a muffle to 900° is heated in an electric kiln in the presence of a steam current between two layers of silica grains. The steel walls of the electric kiln are covered with nickel. The hydrochloric acid is condensed near the kiln where pure sodium silicate is collected. Ninety per cent of the sodium chloride is dissociated at 1250°; at higher temperatures, the chloride vaporizes. By adding lime to the charge in the kiln, an excellent glass for bottles is obtained instead of sodium silicate. M.V.K.

Using nepheline in glass manufacture. S. N. SOLOVIANOV. *Zhur. Khim. Prom.*, **8** [2], 135–41 (1931); *Chim. & Ind.*, **26** [3], 631 (1931).—Nepheline is found in large quantities in the apatite-nepheline mineral and is distinguished chemically by its large content of alumina and the predominance of alkali salts containing potassium over those containing soda. The first researches in using nepheline in glass manufacture were made by the Ceramic Institute of Leningrad in 1927. These investigations showed that nepheline selenite without additions fuses easily but that the mass obtained remains too viscous. Fusions with different admixtures were made and the following mixture was found to be the best: 100 parts nepheline selenite, 105 parts sand, 95 parts chalk, and 3 parts sodium sulphate. After these laboratory tests, a colored glass used for beer and mineral water bottles was manufactured industrially. Other minerals such as obsidian, pumice stone, phonelite, and leucite used as admixtures to the vitreous mass in fusion had the same action as nepheline. Nepheline, on the other hand, requires a very high temperature. A mineral similar to nepheline, *viz.*, phonelite, was tested in Germany with unsatisfactory results. M.V.K.

Light absorption of glass colored by iron oxide. I. I. KITAIGORODSKY, T. A. POPOV, AND N. W. SOLOMIN. *Ceramics & Glass*, **7** [6], 16–19 (1931).—(1) The maximum of transparency is displaced toward the long waves in the majority of glasses with an increase of Fe content and fused with reducers (glasses containing MgO, MgO + CaO, CaO + BaO, ZnO, and ZnO + CaO). (2) Glasses with 1% Fe, which are the most transparent, contain CaO + BaO, CaO + MgO, BaO + CaO + ZnO. Glasses with 3% Fe contain CaO and ZnO and with 6% Fe, BaO, ZnO, and CaO + BaO. (3) Zinc and baryta glasses (without calcium) have a low transparency in the red-orange parts of the spectrum. (4) Glasses most transparent in the violet part of the spectrum possess a certain transparency in the ultra-violet field. M.V.K.

Glass and light rays. A. F. WOODS. *Amer. Glass Rev.*, **51** [5], 20 (1931).—Glasses that will control certain rays and increase or decrease others undoubtedly will be developed. It will be possible to raise many kinds of vegetables and plants under glass which admits or arrests particular rays found beneficial or harmful. E.P.R.

Crystal glasses and their manufacture. ANON. *Céram. Verrerie*, April, 1930; *Ind. chim.*, **17** [203], 865 (1930).—English and French crystal glasses contain a large amount of lead oxide. German crystal glass has less lead. In England and France, crystal glass is fused in closed pots, while in Germany, it is frequently fused in open pots. Constituents used are given. The sand must be prefired to destroy the organic

substances. The usual composition of a French or English glass is 100 kg. sand (60 to 85 kg. minimum), 30 potash, 10 nitrate of potash, 0.20 arsenic, and 0.20 manganese. Half-crystal glasses contain small quantities of lead oxide which is sometimes replaced by baryta. Its composition is 100 kg. white sand, 33 kg. potash (20 minimum), 15 baryta, 3 saltpeter, 1.0 manganese, and 1.0 gram nickel oxide. The famous Bohemian crystal is a potassic calcareous glass. Its hardness is exceptional and its fusing point is very high. The composition of Bohemian crystal glass is 100 kg. white sand, 16 lime, 31 potash, 2 saltpeter, 0.50 arsenic, and 1.0 gram nickel oxide. M.V.K.

Manufacture of quartz glass without bubbles. ANON. *Glashütte*, **60** [52], 953–54 (1930); *Chim. & Ind.*, **25** [5], 1169 (1931); *Ceramics & Glass*, **7** [5], 38 (1931).—Since quartz glass can be fused only at 1700° its manufacture is very delicate. It often has a milky color or is turbid generally owing to a great quantity of microscopic bubbles. To avoid these bubbles, a large block of quartzite or several large blocks separated from each other by quartz sand are fired in an electric kiln. The properties of quartz glass depend not only on its transparency but also on the petrographic structure of the original quartzites. These quartzites should be free from microcrystalline inclosures and have a compact texture without occluded gas; the crystals must be of an exact size and without binding substance. M.V.K.

Stone formations in glass. A. ROSENFELD. *Sprechsaal*, **64** [29], 543–44 (1931).—Stones formed in glass because the clay used for luting cracked and permitted cold air to reach the tank walls and cool it. In these places, a small crust of incompletely fused batch was found. The stones disappeared after luting the cracks in the kiln walls. M.V.K.

Selenium in glass. ANON. *Céram. Verrerie*, June, 1930; *Ind. chim.*, **17** [203], 864 (1930).—Selenium compounds are used for coloration as well as for discoloration of the glass. This substance forms complementary colors. According to German patent 108,595, the following mixture produces a particularly bright glass having the brilliancy of a crystal glass: 30% manganese dioxide, 25% selenium, 20% bismuth oxide, 15% hydrate of nickel, and 10% arsenous acid. Selenium compounds are soluble in some liquids for which glass containers are intended. M.V.K.

Brown coloration of glass by sulphide. ECKERT. *Rev. gén. colloides*, May, 1930; *Ind. chim.*, **17** [203], 864 (1930).—E. studied the action of sulphuric agents on glass. Sulphur has no action. Only alkaline sulphides, polysulphides, and iron sulphide color the glass. The coloring obtained by iron sulphide is more stable than that obtained by alkaline sulphides. A brown coloring is obtained with coal only, especially in the presence of alkaline sulphate. Practical tests show the importance of iron sulphide. M.V.K.

Ruby glasses. H. SCHRADER. *Sprechsaal*, **64** [42], 773 (1931).—Ruby glasses should not be considered as colloids only. Diffusion is an important factor. W.M.C.

Manufacture of blue glass and the decomposition of sodium sulphate by silica. B. BOGITCH. *Ind. chim.*, **17** [203], 864–65 (1930); *Sprechsaal*, **64** [31], 579 (1931); *Ceramics & Glass*, **7** [6], 42 (1931); *Quim. Ind.*, **8** [87], 97 (1931); for abstract see *Ceram. Abs.*, **9** [11], 926 (1930); see also *ibid.*, **10** [4], 301 (1931). M.V.K.

Reasons for different colorings in glasses from exposure. J. HOFFMANN. *Sitz. Akad. Wiss. Wien*, **140**, 11 (1931); *Sprechsaal*, **64** [36], 668–69 (1931).—A series of glasses of different composition were exposed to γ and β rays. The authors give hypotheses but make no definite statement as to the cause for color changes produced. M.V.K.

Apparatus and methods for manufacturing window glass. W. E. S. TURNER. *Engineer*, **159** [3909], 657–60 (1930); *Chim. & Ind.*, **25** [4], 908–909 (1931).—T. reviews different methods of manufacturing window and mirror glass. M.V.K.

Window glass production by the Fourcault method. A. P. Sak. *Ceramics & Glass*, **7** [6], 20–22 (1931).—Of the greatest importance for the production of window glass by the Fourcault method is constant composition, because the definite viscosity and thermal regime depend on it. The usual glass composition containing 16% Na_2O and 10.5% CaO produces a glass of low chemical stability because of its high alkali content. The addition of a small quantity of magnesium oxide and a decrease (up to 10%) of alkali reduce the tendency to crystallize and increase the chemical resistance. Viscosity and annealing temperature are also slightly decreased. S. discusses the reasons for ripples, the principal defect of glass produced by machinery. The composition of the magnesium batch is given. M.V.K.

Avoiding devitrification and deterioration of glasses produced by the Fourcault process. Anon. *Glashütte*, **61** [8], 129–32 (1931); *Chim. & Ind.*, **26** [1], 112–13 (1931).—Two oxides especially recommended for use in the production of glasses by the Fourcault process are barium oxide introduced in the form of barium carbonate and boric acid in the form of borax. Barium oxide lowers the softening point of glass, makes it more fluid at high temperatures, and facilitates its working. The resistance of glass to the destructive action of moisture of the air is increased and the glass becomes more brilliant. About 4% BaO is sufficient. The influence of boric acid is similar but not more than 1% of it should be used to obtain the same effect. Boric acid also greatly increases the mechanical and thermal resistance of glass, although the temperature at which the glass may be worked is somewhat higher than that of glass containing barium or ordinary glass. The best solution is to use both oxides together: 72.5% SiO_2, 0.5% B_2O_3, 16.0% Na_2O, 9.0% CaO, 2.0% BaO. M.V.K.

Advantages of electric heating applied to glass leers. R. M. Cherry. *Chem. Met. Eng.*, **38** [7], 400–402 (1931); for abstract see *Ceram. Abs.*, **10** [12], 835 (1931). G.R.S.

Cooling of glass. Rosenfeld. *Sprechsaal*, **64** [41], 757–58 (1931).—A short review is given on the cooling process of glass. W.M.C.

Recuperative furnace construction. Anon. *Amer. Glass Rev.*, **51** [3], 11–12 (1931).—The type of furnace, fuel, batch, insulation, and other forces must be taken into consideration when computing economy in glassmaking. The Amsler-Morton Co. uses only 4800 cu. ft. of natural gas for every ton of glass melted. A detailed description of the furnace construction and its use in some typical glass plants is given. E.P.R.

Glassmelting tanks. N. J. Sulima. *Ceramics & Glass*, **7** [5], 24–26 (1931).—S. describes the manufacture of glassmelting tanks made from the Tschassoff-Jar clay. A tank with a capacity of 1 T. of glass can be used for an average of 25 fusions. See also *Ceram. Abs.*, **9** [8], 675 (1930). M.V.K.

Action of copper in glass tanks. M. F. Shur. *Glashütte*, **61** [6], 90–91 (1931); *Chim. & Ind.*, **26** [1], 113 (1931).—S. describes tests in which pieces of copper were deposited in a glass tank to ascertain the effect of copper on the glass and the walls of the tank. The copper had no effect or only a very slight one on the walls of the tank; it melted and was partially dissolved in the glass. The glass mass in contact with or near the copper was colored ruby red by the action of the dissolved CuO_2. This color grew paler and changed into pink and green farther away from the copper. M.V.K.

Fused and reconstructed basalt. Alix Cornille. *Céram. Verrerie*, No. 830, pp. 437–39 (1931).—Camille Ribbe in 1913 devised a method for making articles by fusing basalt with subsequent devitrification. One company in Germany is producing 25 to 30 T. of fused basalt per day. In the past, basalt was used for making a black glass of mediocre quality. T.N.McV.

Thallium. Anon. *Chemicals*, **36** [12], 25 (1931).—Sources, properties, and uses

of thallium are given. Because of their high refracting power, thallium compounds are used in the manufacture of certain kinds of optical glass. G.R.S.

Cast glass and its use in modern constructions. ANON. *Génie civil*, July, 1930; *Ind. chim.*, **17** [203], 866 (1930). M.V.K.

Curved glass and kilns for glass curving. B. P. KRAVETZ AND B. A. BOBRISHEV-POUSHKIN. *Ceramics & Glass*, **7** [6], 24–27 (1931).—The theory of glass curving, its practical use, and glass-curving kilns in U.S.S.R. are described. M.V.K.

Kinon everlasting mirrors. GLAS-UND SPIEGELMANUFACTUR. *German Ind. Echo*, 3 (1931); *Nat. Glass Budget*, **47** [22], 19 (1931).—The layer of foil is entirely covered by glass on both sides and is therefore protected from all those injurious influences which might, owing to the natural sensitiveness of the foil, tend to destroy the backing. E.P.R.

Glass silk for heat insulation. ANON. *Mech. World*, **90** [2334], 315–16 (1931).—With a view to producing a reliable heat-insulating covering for boilers and steampipe installations generally, Chance Bros., Ltd., are now manufacturing glass silk which is claimed to have the following qualities: It withstands superheated steam temperatures, is applicable to surfaces while either cold or hot, does not promote or assist corrosion, goes directly on hot surfaces, is sent ready for use, and maintains a high efficiency throughout its life. The material is also nonhygroscopic and incombustible. This new insulating material consists of long fine threads or fibers of glass which are flexible and can be made up into various forms suitable for use as heat insulators. It has all the qualities essential to a good nonconductor of heat. See following abstract. E.P.R.

Glass silk as heat insulator. ANON. *Engineer*, **152**, 150 (1931).—Glass silk insulation is in use on the boilers of the N.D.L. liners "Bremen" and "Europa." The manufacture of glass silk has been commenced at the Firhill, Glasgow, plant of Chance Bros., Ltd. H.H.S.

Manufacture of glass through the ages. ANON. *Nat. Glass Budget*, **47** [27], 3 (1931).—The Glass Room in the Museum of Science and Industry at Chicago, Ill., is designed to show the story of glass in its several phases, particularly the manufacture of glass through the ages. The utilitarian value of glass is stressed, both by the floor studded with vault lights and the ceiling crossed with translucent glass through which comes all of the light which illuminates the room. The more decorative features of glass are shown in the series of wall cases which will contain specimens of glass ornaments and objects of minor utilitarian and major decorative value from antiquity to modern times. Illustrated. E.P.R.

Use of glass in Rome. LENORE VAN DER VEER. *New York Sun; Amer. Glass Rev.*, **51** [6], 11–12 (1931).—The Romans used glass lavishly in many varied forms and colored glass was used widely hundreds of years ago. The Phoenicians are known to have made glass, probably learning the art from the Egyptians, and to have attained proficiency in tinting and shaping. During the reign of the Caesars, glass was put to more purposes and became highly prized as a substance of general utility. The earliest examples of glass having dates attested by inscriptions are of Egyptian origin. A lion's head of opaque bluish glass, fine in color, found at Thebes is the oldest piece yet discovered. On its reverse side are hieroglyphics in which the name of Nauntef IV, whose date, according to Sepius's chronology, was 2428–2380 B.C., appears. A bead of the same dusty green glass bears the praenomen of Hatasu, a queen conjectured to have lived about 1450 B.C. Glass bottles containing wine are represented on monuments of the 4th dynasty, more than 4000 years old. In the tombs at Ben Hassan, dating from the reign of Ursurtesen I, at least 2000 B.C., glassmaking is quite definitely represented. E.P.R.

New England Glass Works. ANON. *Glass Ind.*, **12** [11], 221 (1931).—A description

of this glass plant which dates back to 1818, published originally in 1851, is reproduced. Illustrated. E.J.V.

Spanish glass industry. ANON. *Pottery Gaz.*, **56** [652], 1400 (1931).—Some Spanish glassworks are busy with window glass and the position for crystal glass and bottles is satisfactory. While the Luis Inglada glassworks of Badalona works only three days a week, it is for technical reasons and not for lack of orders. Furnaces are fully engaged. E.J.V.

Report on the activity of the Heat Technical Council of the German glass industry for 1929–1930. ANON. *Feuerungstechnik*, **19** [10], 164 (1931).—The report deals with fuel economy and rationalization, measuring means, kilns, regenerators and burners, coke-kiln gas, waste-heat boilers, investigations, and other details related to the operation of glassworks. M.V.K.

BOOKS

German Glass Industry. (Deutsche Glasindustrie.) Transactions and reports of the Sub-Committee for General Economy. Vol. 14. Published by Mittler and Sohn, Berlin, 1931. Bound 18.50 Rm, unbound 16.50 Rm. Reviewed in *Sprechsaal*, **64** [23], 438 (1931).—Results of investigations made in the pane glass, mirror, bottle, hollow, and hand glass industries of Germany are presented. M.V.K.

Glass. Vol. I. HERMANN THIENE. Reviewed in *Sprechsaal*, **64** [39], 729–30 (1931); for abstract see *Ceram. Abs.*, **10** [10], 691 (1931). M.V.K.

The Mechanization of the Glass Industry. (Mechanizaciya Gutarstva.) L. GESBURG AND S. PERKAL. Ukrainian State Technical Publishing House. Kharkov, 1931. 96 pp. Price 1 Krb. This book is divided into four divisions. In the first division a short review is given of the methods of glass manufacture (hand-blown, casting, pressing, and drawing) and the attempts made in the mechanization of the process of glassmaking by Bontemps (1834), Flamm (1846), Appert (1890), Robinet, and Lippold and Lorenz (1921) are described. The second division deals with the mechanization of window (sheet) glass manufacture. The methods of Lubbers, Sievert, Fourcault, Libbey-Owens (Colburn), and Ford are described. The state of mechanization of window glass industry in U.S.S.R. is summarized. The third division is devoted to the mechanization of bottle and hollow-glass manufacture. The following machines are described: (1) semi-automatic machines (Ashley, Kilner), (2) vacuum machines (Owens, Roirant), (3) feeding machines (Lynch, Owens-Graham), and (4) feeders of Homer Brooke and Rankin and Miller. Continuous annealing furnaces are discussed and a comparison is made of vacuum and feeding machines. The state of mechanization of the bottle glass industry in U.S.S.R. and machines for hollow glassware manufacture are reviewed. The Daubenspeck's machine and the E. Miller pressing machine are briefly described. The fourth division contains an account of the electric lamp-bulb manufacture in which the Westlake machine and a new plant for bulb manufacture (Osram-Werke; Siemensstadt-Berlin) are described. The progress of glass manufacture in the U.S. is reviewed. The vacuum Knox-O'Neill bottle machine and the Corning Glass Works lamp-bulb machine are described. SELICK I. PERKAL

PATENTS

Leer feeder. ALBERT N. CRAMER. U. S. 1,827,738, Oct. 20, 1931. A leer feeder comprising an endless chain, a series of ware pushers arranged at uniformly spaced points along and pivoted to the chain, the pushers normally extending laterally from one side of the chain and adapted to convey bottles along a predetermined path, and mechanical means reciprocating along a path parallel with the chain and operable to swing the pushers one at a time toward the chain to free the bottles from the influence of the pushers.

Grinding and polishing spherical lenses. ARTHUR J. HOLMAN. U. S. 1,827,748, Oct. 20, 1931. In a device, the combination of a lap, a rotatable universal joint supporting the lap, means for simultaneously rotating the universal joint thereby imparting rotation to the lap and oscillating the lap in a manner whereby no point on the lap surface may, during its travel, deviate from an extended spherical surface coincident with its own spherical contour, a lens chuck, and means for retaining a lens carried by the chuck in grinding contact with the lap.

Sealing-off machine for glass objects. JOHN N. SCISM. U. S. 1,827,914, Oct. 20, 1931. (1) In a machine for exhausting and sealing off hollow glass objects having a hollow neck thereon, the combination of a nipple connected to an exhaust line, means for raising the nipple to engage the neck on the glass object, means for heating the neck adjacent the object to its fusion temperature, a mechanical linkage carrying sealing-off dies, the dies being shaped to conform to the cross-section of the periphery of the glass object, and means for automatically operating the linkage to cause the dies to seal off the neck. (2) In a machine for exhausting and sealing off hollow glass objects, the combination of means for connecting the interior of the object to exhausting means, means for heating the glass object at the sealing-off region, and opposed sealing-off dies, the dies having sealing-off faces which are formed to give the sealed portion a shape conforming with the remaining object.

Glass-annealing leer. ERIC AUGUSTUS COAD-PRYOR AND FRANCIS AUGUSTUS HURLBUT. U. S. 1,828,070, Oct. 20, 1931. A glass-annealing leer comprising a series of transverse metal compartments arranged to form the roof and sides of a tunnel, a series of transverse metal compartments arranged to form the bottom of the tunnel, a supply conduit for temperature-controlling medium in communication with the roof and side compartments by separate and independently controllable passages, a supply conduit connected to the bottom compartments by separate and independently controllable passages, outlet ducts communicating with the ends of the compartments for the outflow of the temperature-controlling medium, controlling means associated with the outlet ducts, means whereby any number of the roof and side compartments or the bottom compartments can be cut off from the outflow duct and placed in direct communication with each other, dampers or valves for controlling openings in the inner and outer walls of the compartments whereby communication may be established with outside air through the openings in the outer walls when desired and with the interior of the tunnel when desired, a hinged plate located within the tunnel for preventing a medium in any part of the tunnel from passing into another part thereof, and exterior operating means by which the plate can be set to suit the height of the ware passing through the tunnel.

Feeding molten glass. WILLIAM T. BARKER, JR. U. S. 1,828,216 and 1,828,217, Oct. 20, 1931. (1) The method of obtaining variegated glass charges which comprises flowing molten glass of a base color through a flow channel to a discharge outlet in the bottom of the flow channel, combining with the glass in the flow channel a plurality of smaller streams of glass of a secondary color and discharging the combined streams through the outlet in successive suspended masses, each of such masses having a body formed mainly of glass of the base color and having streaks of glass of the secondary color clearly visible at the surface thereof, twisting each suspended mass about its longitudinal axis during its formation and with respect to the glass entering the outlet to distribute the streaks of glass of the secondary color at the surface of the body of the suspended mass in imitation of the streaks or striations of a body of variegated natural rock, altering different charge masses by varying the durations of the periods of twisting thereof, and severing each suspended mass from the oncoming glass. (2) Glass-feeding apparatus comprising means for flowing molten glass of a given color

from the source of supply to a discharge outlet submerged by the glass, means for introducing glass at the outlet of a different color into the first-named glass below the level of the latter, and means for successively forming the glass into suspended masses and for twisting each of the masses to distribute the glass of different colors therein.

Feeding glass charges of different colors. EVERETT O. HILLER. U. S. 1,828,226, Oct. 20, 1931. The method of automatically feeding mold charges of glass from a plurality of glasses of different colors which comprises imparting rotary movement to converging streams of glass of different colors and mixing the glasses to a point short of blending, delivering the resultant glass in suspended masses below a severing plane, and severing charges therefrom.

Feeding molten glass. GILBERT C. MARSH. U. S. 1,828,229, Oct. 20, 1931. The method of obtaining variegated charges of molten glass which comprises causing molten glass of a plurality of different colors to issue from a final discharge outlet in successive suspended masses, temporarily mechanically engaging the lower end portion of each of the masses and imparting a lifting movement to the glass at the beginning of the period of formation thereof, imparting a rotary motion to the glass to distribute the colors thereof, controlling the distribution of the colors in the masses by varying the extent of lifting movement and the speed of rotary motion imparted thereto, and severing each mass, when formed, at a plane spaced below the discharge outlet.

Feeding molten glass. KARL E. PEILER. U. S. 1,828,438, Oct. 20, 1931. (1) The method of segregating molten glass to form mold charges of weights varying in a regular order in periodically recurring cycles which comprises intermittently discharging the glass through an outlet, intermittently retarding issuance of glass from the outlet by an implement movable below the outlet, periodically severing mold charges from the discharged glass, and periodically varying the length of the successive discharge periods in each of the cycles in accordance with the schedule of weights desired. (2) In glass-feeding apparatus, a container for molten glass having an outlet in its base, a movable supporting member adjacent to the container, a discharge-regulating member outside the container and movable with the supporting member from the outlet, a periodically operated member for periodically actuating the supporting member to move the discharge-regulating member toward the outlet, and means adjustable on the supporting member for coöperating with the actuating member to vary the position of the path of movement of the discharge-regulating member relatively to the outlet.

Glass feeder. CARL H. RANKIN. U. S. 1,828,442, Oct. 20, 1931. In combination in a feeder for molten glass, a receptacle for molten glass, an orifice through which glass from the receptacle is delivered, and a reversible pump mechanism rendered effective by its rotation to control positively the flow of glass through the orifice.

Feeding molten glass. CARL H. RANKIN. U. S. 1,828,443, Oct. 20, 1931. (1) In combination with an apparatus for feeding molten glass, a rotatable receptacle having a flow orifice formed in the bottom thereof and at the center of rotation thereof, a reciprocable plunger projecting into the receptacle and aligned with the orifice, a sleeve surrounding the plunger and projecting into the orifice, and means for rotating the receptacle, the plunger, and the sleeve at the same angular velocity. (2) The combination in a melting tank for glass of an extension having a communication with the tank by a passage opening through the bottom of the extension and provided with two glass-delivery passages for receiving glass from the tank through the first-named passage and a valve in each of the second-named passages. (3) Apparatus for feeding molten glass comprising a discharge receptacle for the glass having a discharge outlet in its bottom, a plunger depending into the glass in the receptacle and reciprocable toward and from the outlet to control discharge of glass through the outlet, a tube surrounding the plunger for regulating the flow of glass to the outlet, a hinged supporting member

extending above the receptacle and carrying both the plunger and the tube, and means also carried by the hinged supporting member for adjusting the positions of the reciprocable plunger and the tube with respect to the outlet.

Mechanism for manufacturing glassware. WILLIAM J. MILLER. U. S. 1,828,674, Oct. 20, 1931. The combination with a feeder mechanism for producing mold charges of molten glass which comprises a receptacle for the molten glass having a submerged discharge outlet, mechanically operated shears arranged periodically to open and close beneath the outlet to sever the masses of glass depending from the outlet, and means for timing the operation of the shears, of a nozzle arranged to discharge lubricant upon the cutting portions of the shears, a supply of lubricant under pressure connected to the nozzle, an interrupter interposed in the connection, means for periodically actuating the interrupter to admit lubricant to the nozzle, and means for regulating the timing of such actuations independently of the timing of the operations of the shears.

Suction feeder. KARL E. PEILER AND WILLIAM T. BARKER, JR. U. S. 1,828,717, Oct. 20, 1931. (1) In glass-gathering apparatus, a receptacle having an open end, means for periodically moving the receptacle to and from position to dip at its open end into a body of molten glass, means for initiating a period of suction in the receptacle each time the receptacle dips into the glass and for subsequently terminating the period of suction, and separate means for independently adjusting the times of beginning and cessation of the period of suction in the receptacle for any selected cycle of operations of the receptacle. (2) In glass-feeding apparatus, a forehearth having a gathering opening through which portions of glass may be gathered periodically from the surface of a supply body of molten glass in the forehearth, the forehearth having its bottom wall inclined adjacent to the gathering station, and means operating in the glass in the forehearth for moving glass of the supply body on the inclined bottom wall and at the gathering station. (3) In glass-gathering apparatus, a glass-holding member having a normal cycle of movement when charged from a starting position to a plurality of discharge stations in series and back to the starting position, and means for predetermining the particular discharge station at which the outward movement of the receptacle from the starting position will be stopped to permit discharge of its contents.

Feeding molten glass. KARL E. PEILER. U. S. 1,828,720, Oct. 20, 1931. (1) In apparatus for feeding molten glass, the combination with a glassmelting container of a basin for the glass provided with a discharge outlet, a gate block having a vertical flow passage therein, a flow passage having walls diverging from the vertical passage to the container, a flow passage having walls diverging from the vertical passage to the basin, and an adjustable gate member for controlling the flow of glass through the vertical passage. (2) Apparatus for discharging molten glass from an outlet in a container having in combination an outlet ring, a pivotally mounted carrier therefor, a lever having an end adapted to swing beneath the carrier as it approaches final position, and means for securing the lever in position to hold the carrier in operative relation to the outlet.

Feeding molten glass. WILLIAM A. LORENZ. U. S. 1,828,726, Oct. 20, 1931. (1) In apparatus for separating mold charges from a mass of molten glass in a container having an outlet, the combination of a plunger movable toward and from the outlet to control the discharge of glass therethrough, a rotatable carrier, a plurality of cam members mounted on the carrier, a lever actuated by the cam members and connected to move the plunger, each of the cam members being adapted to cause a reciprocation of the plunger, and means for independently adjusting the cam members during the operation of the apparatus. (2) The method of feeding molten glass from a delivery outlet of a glass container in mold charges in successive cycles, each cycle covering the

discharge of a plurality of successive masses of independently regulable sizes, which comprises accelerating and retarding discharge of glass through the outlet a plurality of times in each cycle, regulating the relative sizes of the respective masses of glass discharged through the outlet in that cycle and in each subsequent cycle by regulating the time intervals between successive periods of accelerated and retarded discharge in a cycle, and severing a mold charge from each of the discharged masses.

Glassmelting furnace. JOSEPH P. CROWLEY. U. S. 1,828,830, Oct. 27, 1931. A glassmelting furnace including a melting tank having a plurality of air-intake ports, a plurality of regenerators, one communicating with each of the ports by means of a substantially horizontal passage for supplying air thereto, and a plurality of relatively small gas boxes, one being provided beneath each of the passages inwardly of its respective regenerator and closely adjacent the furnace, the boxes communicating with the furnace in proximity to the ports for supplying gas thereto.

Sheet-glass apparatus. JOHN L. DRAKE. U. S. 1,828,832, Oct. 27, 1931. In combination in sheet-glass apparatus, a horizontal, traveling, endless conveyer of link construction for drawing a sheet vertically from a mass of molten glass, sprocket means about which the conveyer is trained at the opposite ends of its loop, a bending member for deflecting the sheet from the vertical into the horizontal plane, the bending member being positioned slightly above the level of the adjacent end of the upper horizontal sheet-supporting run of the conveyer, and means positioned beneath the sheet between the conveyer and bending member and adjacent the former for creating an air cushion beneath the sheet to support it and to cause it to contact initially with the conveyer inwardly of the buckling-up point of the links as the links pass about the sprocket means into the horizontal plane.

Glassmelting furnace. JOHN L. DRAKE. U. S. 1,828,833, Oct. 27, 1931. In a glassmelting furnace, an elongated melting tank of greater length than width and being provided with oppositely disposed longitudinally extending ports in the side walls thereof, coöperative regenerators at the sides of the tank having substantially horizontal air passages communicating with the respective ports and being of a width substantially equal to the length thereof, a gas box positioned beneath each horizontal air passage and being in communication therewith the entire width of the horizontal passage, each gas box being provided with a plurality of spaced openings in its bottom wall, a gas pipe positioned beneath the gas box and extending longitudinally thereof and having a plurality of outlets in communication with the respective openings, and separate means for independently controlling the supply of gas to each opening.

Producing sheet glass. JOHN L. DRAKE. U. S. 1,828,834, Oct. 27, 1931. The process of producing sheet glass consisting in forming the sheet at a relatively high rate of speed, laying the sheet as it is formed upon a conveying means, carrying the conveying means bodily forward at a speed substantially equal to the speed of formation of the sheet to receive the same thereupon, in stopping the forward bodily movement of the conveying means, and in then driving the conveying means independently of its forward bodily movement to deliver the sheet therefrom into an annealing chamber at a speed relatively less than its speed of formation.

Producing sheet glass. JOHN L. DRAKE AND WILLIAM E. NOBBE. U. S. 1,828,835, Oct. 27, 1931. In combination in apparatus for the manufacture of sheet glass, means for forming the sheet, a glass-supporting table having a tiltable top adapted to receive the sheet thereupon from the forming means while disposed in a substantially horizontal position, an annealing leer, means interposed between the table and leer for receiving the sheet from the former and delivering it into the latter including a series of rotatable members, each member including a plurality of transversely spaced roll sections, a plurality of spaced supporting bars pivotally mounted and adapted to be tilted

upwardly to receive the sheet from the table when the top of the table is also inclined and adapted to be lowered to deposit the sheet upon the members, and means for rotating the members to advance the sheet into the leer, the bars when lowered being received within the spaces between the roll sections.

Furnace construction. LEOPOLD MAMBOURG. U. S. 1,828,843, Oct. 27, 1931. A furnace adapted to contain a mass of molten glass and including a melting end, a working end for receiving the molten glass from the melting end, the bottom of the furnace being formed with a raised portion at substantially the transverse center thereof, and a floater having a depending portion also at substantially the transverse center of the furnace and positioned directly above the raised portion, the floater coöperating with the raised portion to form a throat through which the glass passes from the melting end into the working end.

Sheet-glass drawing apparatus. JOSEPH M. NEENAN. U. S. 1,828,845, Oct. 27, 1931. In sheet-glass apparatus, means for drawing a sheet from a mass of molten glass, an air pipe extending transversely of the sheet for directing a supply of air onto the sheet prior to its engagement with the drawing means, and means for preventing sagging of the pipe.

Take-off and leering conveyer for sheet-glass forming machines. RICHARD GENENGER. U. S. 1,829,134, Oct. 27, 1931. The combination with a sheet-glass forming machine of a leer for the glass formed thereby, a bed within the leer adapted to support the sheets and consisting of a series of blocks with serrated upper faces, idler rolls interposed in the bed, and driven rolls above the idler rolls with means for lifting and lowering the upper rolls.

Producing sheet glass. CHARLES B. KINGSLEY. U. S. 1,829,409, Oct. 27, 1931. The method of producing reinforced wire glass which comprises feeding molten metal to a sheet-forming pass, cooling one surface of the metal before it reaches the pass whereby the cooled surface is stiffened, feeding reinforcing wire into the metal after the stiffened surface is formed, and limiting the depth of penetration of the wire into the metal by the thickness of the stiffening surface.

Drawing glass. WILLIAM J. WOODS. U. S. 1,829,429, Oct. 27, 1931. In an apparatus for drawing glass, the combination with a container for a bath of molten glass, means for drawing glass from the bath, means submerged below the surface of the glass for shaping it as it is drawn, and means for cooling that portion of the glass from which the draw takes place, of a frame within the container for receiving glasses of a different character and retaining them in a restricted zone on the surface of the glass bath in such a position that when the draw takes place all glasses will be drawn simultaneously.

Drawing sheet glass. ENOCH T. FERNGREN. U. S. 1,829,639, Oct. 27, 1931. In an apparatus for forming continuous sheet glass, a receptacle for molten glass having an orifice in its bottom, a pair of directing members extending down through the orifice, the molten glass flowing down in three separated streams, one between the members and one between each member and the adjacent side of the orifice, and means for mounting the members whereby they may yield toward or from one another to vary the proportionate volumes of the side and central streams.

Making the border seal of laminated glass. ROBERT W. HACKETT AND ARTHUR G. WORRALL. U. S. 1,829,647, Oct. 27, 1931. The method of sealing the edges of laminated glass composed of two glass sheets with an interposed celluloid sheet which consists in the removal of the perimeter edges of the celluloid sheet to a short distance by the employment of the cutting action of a rapidly rotating fine wire brush whereby the abrading action thoroughly cleans the binding material from the faces of the glass sheets forming the side walls of the groove, and thereafter introducing a sealing sub-

stance into the groove whereby it seals the same and attaches itself to the glass and celluloid surfaces therein.

Forming sheet glass. ENOCH T. FERNGREN. U. S. 1,829,640, Oct. 27, 1931. (1) The process of drawing a sheet of glass which consists in merging three descending glass streams within a heated zone, in checking the descent of two of the streams above their merging point to increase their quantity adjacent to the point, and in drawing a sheet from the merging point of the glass stream. (2) In an apparatus for forming continuous sheet glass, a pair of similar directing members arranged adjacent one another to provide an open passage therebetween, means for flowing molten glass onto the upper edges of the members, the glass flowing down between the members and also down the outer sides thereof, the three streams uniting below the members and being drawn away in sheet form, the members being provided on their outer faces with means for retaining a supply body of glass in each outer stream adjacent the point where the streams merge, means for applying heating to these glass supplies, and means for locally cooling the glass where the three streams unite.

Downflow sheet drawing apparatus. ENOCH T. FERNGREN. U. S. 1,829,641, Oct. 27, 1931. In the art of drawing sheet glass, a slab having downwardly convergent sides, means to flow glass down both sides of the slab and to draw the streams from the slab in sheet form, and means projecting outwardly from the slab to build up a reservoir of glass between its introduction to the slab and the point where it is drawn from the slab to produce a smooth uniform sheet of glass.

Producing sheet glass. CARROLL CONE AND EDWIN A. ROSIN. U. S. 1,829,738, Nov. 3, 1931. In sheet-glass apparatus, a receptacle containing a mass of molten glass, a pair of rolls mounted thereover and arranged to create a sheet-forming pass, one of the rolls being supported in a stationary mounting, linkage means for adjustably supporting the other roll with respect to the first, means for controlling the space between the rolls, and means for indicating the space between the rolls.

Manufacture of hollow articles of quartz and similar bodies of high melting point and the furnace thereof. FRITZ DOERINCKEL AND MARTIN SCHLIEMANN. U. S. 1,829,821, Nov. 3, 1931. Apparatus for the manufacture of hollow quartz bodies open at one end comprising a furnace the inner part of which has the shape of the article to be produced, the furnace having a perforated false bottom and a movable bottom, a movable cover attached thereto, an electric heating resistance reaching into the interior of the furnace, the resistance being so shaped that the heating element can be withdrawn from the hollow article without damaging it, means at one end of the resistance for supplying the current thereto, and tongs placed between the furnace and the cover thereof.

Coloring lamps. JOHN T. FAGAN. U. S. 1,830,598, Nov. 3, 1931. The method of coloring open-ended hollow glass articles which consists in placing in a container a supply of coloring powder, supporting the article with its open end sealed over the end of a conduit, directing an air blast through the container to draw into the blast a supply of the powder and to deliver it through the conduit into the article, causing the mixture of return air and excess powder to be directed into a separating bag, and causing the separated powder to be returned to the supply in the container.

Manufacture of sheet glass. LAURENCE P. FORMAN. U. S. 1,830,788, Nov. 10, 1931. A cooler for use in glass drawing comprising a body having different surface portions treated differently to produce surfaces of different heat-absorbing quality.

Feeding glass. WILLIAM J. MILLER. U. S. 1,830,849, Nov. 10, 1931. Means for feeding glass from a mass consisting of a conduit extending upwardly through the mass having an upper inlet opening extending above the level of the mass and a lower de-

livery opening, and a coacting impeller adapted to effect flow into the conduit and outwardly therefrom.

Window glass. FRED W. RENZ. U. S. 1,830,887, Nov. 10, 1931. A pane of glass having both sides smooth and flat throughout their area and having spaced, intersecting, narrow, translucent lines on one side defining small clear-vision areas.

Table feed mechanism for grinding, smoothing, and polishing apparatus. SÉRAPHIN WEROTTE. U. S. 1,830,895, Nov. 10, 1931. An apparatus for grinding, smoothing, and polishing glass, marble, etc., including one or more rows of tables arranged one after another, a continuous forward-feed mechanism for the tables disposed beneath members which always perform the same work, the feed mechanism being arranged at the beginning of the row of tables and including several driving members and pinions on vertical axes driven by the members, and gearing with racks carried by the tables, the pinions in a row parallel to the direction of movement of the tables being separated from one another by a distance equal to a multiple of the pitch of the teeth increased by a length equal to that of the pitch divided by the number of pinions in one row.

Ultra-violet transmitting substance. HARRISON PORTER HOOD. U. S. 1,830,902, Nov. 10, 1931. The method of making a glass containing substantial quantities of zinc and transparent to the ultra-violet which comprises so decreasing the iron and lead contents in the glass ingredients and so melting the mixed ingredients that the resultant glass contains less than 0.03% of ferric oxide and less than 0.02% of lead oxide.

Producing substance transparent to ultra-violet light. HARRISON P. HOOD. U. S. 1,830,903, Nov. 10, 1931. A phosphate glass whose ferric oxide content is small is transparent in thicknesses of 4 mm. to light waves shorter than 300 millimicrons.

Making ultra-violet transmitting glasses. HARRISON P. HOOD. U. S. 1,830,904, Nov. 10, 1931. The method of making ultra-violet transmitting glasses which consists in decreasing the iron contents of batch materials which are otherwise suitable for the production of ultra-violet transmitting glasses to less than 0.010 of 1% and melting these batch materials under oxidizing conditions.

Production of glass in strip form. ERNEST BRISTOW LE MARE. U. S. 1,831,015, Nov. 10, 1931. Roller-bed for intermittently receiving hot glass strips at a high speed and reducing their speed comprising a first group of rollers, a single driving means therefor adapted to drive the rollers continuously at a constant speed corresponding to the speed of formation of the strip, a second group of rollers, a single driving means therefor tending to drive the rollers thereof at a constant low speed, and a free-wheel clutch between the latter driving means and each one of at least a portion of the rollers of the second group adapted to permit each of the rollers to turn freely at a higher speed than its driven speed.

Rolling sheet glass. JOHN L. DRAKE. U. S. 1,831,060, Nov. 10, 1931. The process of producing sheet glass which consists in flowing molten glass from a tank furnace into a forehearth having an exposed drawing bay, maintaining the glass in the drawing bay at such a level that it contacts with the lower portions of the peripheries of a pair of longitudinally ribbed rolls situated thereabove, and rotating the rolls in such a way that the glass is drawn upwardly therebetween and reduced to sheet form.

Making laminated glass. WILLIAM HENRY MOSS. U. S. 1,831,462, Nov. 10, 1931. The method of making laminated glass comprising coating the surface of at least one of the components of glass and a plastic sheet containing a derivative of cellulose and triacetin with an adhesive coating composition containing a vinyl compound, interposing the plastic sheet between sheets of glass, and then pressing.

Spraying glass, etc. JOHN HENRY JUERS. U. S. 1,831,535, Nov. 10, 1931. An apparatus for spraying glass, etc., comprising a spray head, means to reciprocate the spray head including a swinging arm, and means to guide the spray head on the chord

of the arc centered on the pivot of the swinging arm with its axis radial to the same center, whereby the spray head is reciprocated in a rectilinear path parallel with the plane in which the arm swings.

Pressing glass articles. EDWIN E. SLICK. U. S. 1,831,548, Nov. 10, 1931. An apparatus for forming glass articles, etc., which comprises a mold having a bottom plate provided with an opening therethrough, a press including an upper and a lower member resiliently connected to each other, a plunger rigidly connected to the upper member and slidable through an opening in the lower member, the lower member being adapted to form a blank, the plunger being adapted to stamp out an article from the blank, and an auxiliary plunger mounted in and projecting below the first-mentioned plunger in order to form an opening in the article.

Method of bedding glass sheets on supporting table. DANIEL ADAMS. U. S. 1,831,617, Nov. 10, 1931. The method of bedding glass sheets upon the top of a table which consists in first depositing upon the table a mixture of sand and water to form a semisolid bed, laying a sheet upon the bed, and in then removing the water from the mixture thereby causing the sand to solidify and secure the sheet upon the table.

Producing molten glass. HORACE E. ALLEN. U. S. 1,831,619, Nov. 10, 1931. In molten glass-producing apparatus, a melting tank containing a mass of molten glass and rotatable about a substantially horizontal axis, means for introducing raw glass-making materials into one end of the tank, heating means at the same end of the tank for melting the raw materials to form molten glass, a refining tank at the opposite end of the melting tank for receiving the molten glass therefrom, and means within the melting tank for creating a pool of molten glass therein at the heating end thereof and for restraining the glass in such a manner that it will flow from this pool by gravity into the refining tank in a relatively thin stream.

Forming sheet glass. CARROLL CONE. U. S. 1,831,620, Nov. 10, 1931. In sheet-glass apparatus, a substantially horizontally disposed substantially cylindrical casing, partition means within the casing intermediate its ends dividing the interior thereof into a pressure compartment and a glass-receiving compartment, the glass-receiving compartment being flared outwardly at one end and provided with an opening constituting a sheet-forming pass, a horizontally disposed plunger slidable through the partition means within the casing and having a head at one end disposed within the glass-receiving compartment and a piston at the opposite end disposed within the pressure compartment, a compression spring encircling the plunger within the pressure compartment and normally tending to move it rearwardly, and means for forcing the plunger forwardly against the action of the spring whereby the glass is forced from the glass-receiving compartment through the sheet-forming pass in sheet form.

Producing sheet glass. JOHN L. DRAKE. U. S. 1,831,622, Nov. 10, 1931. In sheet-glass apparatus, a slab having two substantially identical sides, each end of the slab terminating in an angular extension, means for turning the slab over, means for depositing molten glass on the upturned side of the slab, and means for forming the molten glass into a sheet.

Forming sheet glass. JOHN L. DRAKE. U. S. 1,831,623, Nov. 10, 1931. In sheet-glass forming apparatus, a tank containing a mass of molten glass and having a pair of spaced substantially parallel boots at one end thereof, each boot being provided with an opening in its bottom, a receptacle positioned beneath each boot for receiving the molten glass therefrom, and a pair of forming rolls mounted at one end of each receptacle for receiving the molten glass therefrom and reducing it to sheet form.

Sheet-glass apparatus. LEOPOLD MAMBOURG. U. S. 1,831,629, Nov. 10, 1931. A draw table for use in the manufacture of sheet or plate glass comprising a plurality of pivotally associated links arranged in an endless belt formation, a plurality of slab

members arranged transversely of the table and supported upon the links, and means removably carried by certain of the links and engaging the adjacent ends of the corresponding slabs for preventing lateral displacement thereof.

Surfacing sheets of glass, etc. INGVALD O. PEDERSEN AND ERIK G. STAHLE. U. S. 1,831,634, Nov. 10, 1931. Means for driving a series of glass-supporting tables along a track including an endless traveling cable extending longitudinally of and associated with the track, rotatable members about which the cable is trained and by means of which it is supported, a cam track arranged adjacent the cable, a gripping member pivotally carried by each table and including a substantially horizontally disposed hook portion adapted to grip the cable to effect movement of the table along the track, the hook portion being of integral construction, and means carried by the gripping member and adapted to ride up on the cam track to swing the hook portion bodily in a vertical arc transversely of the table out of the path of the rotatable members as the truck is passed by the same, the gripping member adapted to be automatically moved to again engage the cable after the table has passed the rotatable member.

Sheet-glass drawing apparatus. JOSEPH A. REECE. U. S. 1,831,639, Nov. 10, 1931. In sheet-glass drawing apparatus, a draw table comprising a plurality of links pivotally associated with one another in an overlapping and intermeshing relation to form a link-belt conveyer, and individual face plates secured to the links and being of a greater width than the links whereby to fill up the spaces between the links to create a substantially unbroken surface upon which the glass sheet is adapted to rest.

Glassworking machinery. GEORGE A. MILLAR. U. S. 1,832,039, Nov. 17, 1931. In combination in a machine for working glass tubing, means for holding one end of a glass tube and means for holding the other end of the tube comprising a plate suspended between a plurality of springs, a conical member having its small end mounted to the plate and having its large end facing the holding means, a perforate stopper member within the conical member, means for applying air pressure through the perforate stopper to the interior of the tube held thereby, a guide member extending about the sides of the conical member, and means in the cone for steadying a glass tube therein comprising spring members extending toward the center of the cone.

Melting furnace. HARRY M. THOMPSON. U. S. 1,832,063, Nov. 17, 1931. A furnace for melting glass comprising a hearth having a continuous sinuous channel for the melting and flow of the glass in at least three reaches including an initial melting reach and a terminal work-out reach, side and end walls enclosing the hearth, a roof forming with the hearth and walls a single combustion chamber, means for supplying fuel to the combustion chamber, an opening for supplying melting stock to the melting reach, and an opening for withdrawing molten glass from the work-out reach.

Blowing hollow-glass articles. RUSSELL G. ALLEN. U. S. 1,832,080, Nov. 17, 1931. In a glass-forming machine, the combination of an air motor comprising a vertically disposed cylinder, a piston movable up and down therein, a piston rod, a blowing head carried by the rod, a latch normally held in inoperative position, and manually operated means to set the latch and cause it to automatically lock the piston rod and associated parts in their elevated position when moved to the position.

Beveling glass. LOUIS ROSENBERG. U. S. 1,832,244, Nov. 17, 1931. In a machine for beveling glass, a grinding disk, a casing therefor open only along its front diameter, flexible curtains at the ends of the opening, a shaft passing through the casing and carrying the disk within the casing, and means for feeding water and a grinding material to the disk.

Glass feeder. THOMAS STENHOUSE. U. S. 1,832,331, Nov. 17, 1931. A glass feeder including a flow spout having a flow orifice, a plug mounted in vertical align-

ment with the orifice, and a dam spaced from the plug, carried thereby, and extending only partly therearound.

Leer feeder. HARRY L. WITTMAN. U. S. 1,832,343 and 1,832,344, Nov. 17, 1931. (1) A leer feeder including a pusher bar, means for moving the bar into and out of the leer, means for raising and lowering the bar, the two means being so related that the bar is moved backward slightly before being elevated, and a spring for assisting the slight backward movement. (2) A leer feeder including a cross conveyer extending across the front of a leer, a pusher bar movable across the cross conveyer, the cross conveyer adapted to receive pans normally spaced apart and projecting over one edge of the conveyer, an obstructor bar, and means for moving the obstructor bar into the path of the projecting portions of the pans, the means being operated in accordance with the number of pans on the cross conveyer.

Manufacturing marbled and multicolored glass. CLAUDE LOCREILLE. U. S. 1,832,491, Nov. 17, 1931. A process of manufacturing marbled and multicolored glass comprising preparing a mass of ground-color glass and masses of variously colored glasses having substantially the same composition, melting the ground-color glass at a temperature between 1200°C and 1400°C, melting the variously colored glasses at temperatures between 1000°C and 1200°C, separately pouring quantities of the variously colored glasses into the ground-color glass at different spots, and rapidly mingling the masses together.

Bottle. JOHN H. DAWSON. U. S. 1,832,806, Nov. 17, 1931. A hermetically sealed shipping and storing package comprising a dispensing container made of ceramic material, bottle-like in form and having a hollow body open at its top, the body being of a diameter to be grasped in a person's hand and of sufficient length to project above the hand when grasped, the open top of the body being of a diameter substantially equal to the diameter of a cross-section of the body to receive a person's mouth and permit drinking contents of the container directly therefrom, a bead being formed about the open top of the body, and a removable sealing cap for the open top of the body having walls crimped about the bead.

Forming hollow glassware. AUGUST KADOW AND THOMAS A. BRAGG. U. S. 1,832,810, Nov. 17, 1931. In combination, a partible neck mold, partible blank and finishing molds adapted to coöperate in alternation with the neck mold at regular time intervals, a housing surrounding and spaced from the neck mold and providing a chamber enclosing the sides and top portion of the neck mold, an annular flange depending from the lower side of the housing and adapted for sealing contact alternately with the blank and finishing molds, means to exhaust air from the housing and neck and blank molds at regular time intervals, and means to supply air under pressure to the neck and finishing molds periodically.

Glassware-forming machine. JOHN E. MCLAUGHLIN. U. S. 1,832,814, Nov. 17, 1931. In a glassware-forming machine, the combination of a blank mold having an open end through which mold charges of molten glass enter the mold, charge-severing means including a closure plate, a cutter movably mounted on the plate, a rock shaft supporting the plate and cutter, means to rock the shaft to thereby move the plate and cutter laterally across the open end of the mold, an eccentric at the lower end of the eccentric shaft, connection between the eccentric and cutter, and means to impart rotary movement to the eccentric shaft to thereby actuate the cutter independently of the plate.

Making laminated glass. F. B. DEHN. Brit. 358,149, Oct. 14, 1931.

Metal to glass seals. ASSOCIATED ELECTRICAL INDUSTRIES, LTD. Brit. 358,934, Oct. 28, 1931.

Adjusting the thickness of cast glass plates and sheets. Y. BRANCART. Brit. 359,360, Oct. 28, 1931.

Electric insulators. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 359,361, Oct. 28, 1931.

Refining glass, etc. A. FOURLINNIE. Brit. 359,801, Nov. 4, 1931.

Structural Clay Products

Ceramics. R. LOGIE. *Jour. Accountancy*, **52** [3], 172–86 (1931).—The ceramic industry was found to be an interesting study for the accountant. A description of clay is followed by an outline of its uses and products. Under organization, L. stresses the need for careful study of physical and chemical properties of each clay deposit, the kind of products for which it is best suited, the type of machinery, driers, kilns to be used, cost of fuel, labor markets, cost of land, construction of plant, working capital, and market conditions. Mining and quarrying, storing, and preparation of clay are discussed. The manufacture of sewer pipe is described in detail. Success of sales organization depends largely on the ability of the production department to make an article of quality at a price which will sell in a competitive field. Control of production is a sales estimate of budget to which the whole organization works. Predominant factors in determining low costs are efficient plant planning and economical firing. Sewerpipe plants are operated at an approximate average of 60% capacity. An investment made for the services of an industrial engineer and the installation of a proper cost system would benefit the plant operator and also tend to stabilize the industry. A cost of production system should cover (1) actual cost in material and labor by departments, (2) determination of overhead and general expenses by departments and the proper allocation to the product, (3) establishment of a normal unit cost by operations for comparison with actual cost figures, (4) maintenance of perpetual inventory records to control quantities, (5) cost records to furnish data relative to all operations in the manner which will permit close regulation and to provide for exceptional conditions, *e.g.*, as those caused by shut-down of plant, (6) establishment of controls in cost records to afford a ready method of reconciling results with financial records. Firing and labor costs and overhead and its distribution are treated. Standardization of the product is needed to relieve the heavy burden of the manufacturer who is required to carry three different types of each size of pipe. Delivery expenses, marketing management, and sales organization are briefly discussed. Through advertising the merits of clay sewer pipe, the industry could be benefited. See also *Ceram. Abs.*, **10** [12], 868 (1931). G.R.S.

Value of sedimentary clay in brick industry. ALBERTO PELLACINI. *Corriere Ceram.*, **12** [9], 369–73 (1931).—After describing properties of sedimentary clays P. gives the methods of obtaining and handling the clay and the construction of pits. M.V.K.

Strength of prisms and cubes made from brick. DROEGSLER. *Tonind.-Ztg.*, **55** [85], 1184–85 (1931).—Results of experiments are given which show that the strength of a prism amounts to about two-thirds that of a cube parallel to the direction of the "fiber" (direction in which the brick are pressed). The strength of the cube vertical to the fiber and parallel to its height is less than the strength of the cube parallel to the fiber. The deviations from the mean value are smaller with prisms than with cubes. W.M.C.

Making multicolored brick. ANON. *Brit. Clayworker*, **40** [474], 245–46 (1931).—The numerous shades and tones produced in multicolored brick are principally due to the action of incompletely burned products from the fuel or the iron compounds present in the clay and in the sand with which such brick are usually faced. Merely to know this fact is insufficient. Careful observation and trial are required to determine how long the brick can be maintained at the hottest temperature of firing without distor-

tion occurring. Suggestions are given for obtaining a desired color, *e.g.*, mixing different clays, restricting supply of air, addition of a small percentage of manganese dioxide, etc. The most satisfactory kilns for multicolored brick are generally of the downdraft type. Firing is the same as for common brick up to about 1100°C. Reduction and partial reoxidation are resorted to for the desired colors and tints. R.A.H.

Origin of color produced on red bodies by zinc vapors. A. McKinley Greaves-Walker. *Clay-Worker*, **96** [3], 155–56 (1931); see also *Ceram. Abs.*, **10** [9], 640 (1931). E.J.V.

Manufacture of hollow brick. Hertrampf. *Tonind.-Ztg.*, **55** [80], 1127 (1931).—The possibilities of making hollow brick are discussed. W.M.C.

No-Fo-T-brick. Anon. *Tonind.-Ztg.*, **55** [83], 1165–66 (1931).—A new hollow brick of T-form is described which is manufactured in two different sizes. Illustrations show how it is used. W.M.C.

Green sand-lime brick. B. Krieger. *Tonind.-Ztg.*, **55** [83], 1162 (1931).—Experiments and plant observations have shown that it is not advisable to have the green sand-lime brick in air for a long period before the hardening process because they will become dry and will show less strength than brick hardened immediately after pressing. W.M.C.

Does engobing of brick eliminate efflorescence? A. Hielscher. *Tonind.-Ztg.*, **55** [77], 1082–83 (1931).—It was found that the engobe does not prevent efflorescence. W.M.C

Water-tight brick masonry. F. O. Anderegg. *Brick Clay Rec.*, **79** [7], 291–300 (1931); see also *Ceram. Abs.*, **9** [6], 428 (1930). E.J.V.

Building with hard-fired brick. Anon. *Tonind.-Ztg.*, **55** [78], 1100–1101 (1931).—Some problems connected with the construction of buildings using hard-fired brick are briefly outlined. W.M.C.

Clay products and steel home. Anon. *Brick Clay Rec.*, **79** [9], 416–17 (1931).—"Manufacture of houses with steel frames and walls of clay tile and brick will go into quantity production within the next few years," was the prediction at the public certification of a welded steel frame house with walls of brick and tile in Shaker Heights, Cleveland, Ohio, by the Cleveland Clay League and the Common Brick Manufacturers Association. Illustrated. E.J.V.

Combination reinforced clay tile and concrete floors. F. E. Emery. *Brick Clay Rec.*, **79** [9], 414–16 (1931).—In ribbed floor and roof construction in which structural clay tile is used as an integral part of the slab, with reinforced concrete ribs running in either one or both directions and with or without concrete topping, the tile adds strength due to its greater compressive strength. A table is given of safe loads superimposed on structural tile and concrete one-way slabs in resistance to bending and shear. A detailed explanation of factors considered is presented. E.J.V.

Reinforced brick trestle gives stability at low cost. Anon. *Brick Clay Rec.*, **79** [9], 420 (1931).—Reinforced brickwork was used in the 21 piers supporting the 20 spans of a 291-ft. industrial track trestle recently built for the Wedron (Ill.) Silica Co. Based on competitive prices, the cost per pier was $68.50 for reinforced brick masonry, $98 for reinforced concrete, and $120 for structural steel supports. E.J.V.

Brick pavement in international judgment. Anon. *Tonind.-Ztg.*, **55** [71], 1007–1008; [73], 1034–36 (1931).—A review is given of the 6th international congress held at Washington for the building of roads. Statistical data concerning brick pavements, dimensions of brick, different ways of building roads, and manufacturing and testing of brick are discussed. W.M.C.

Clay products chosen for building Boulder City. Anon. *Brick Clay Rec.*, **79**

[9], 387–88 (1931).—Boulder City, Nevada, is to be a city of brick. Some of the larger buildings are to have solid exterior walls of brick while the residences will use the "Ideal Rolok" type of construction. Beside brick, structural tile, fire brick and flue lining, roofing tile, and vitrified clay sewer pipe are being used. Illustrated. E.J.V.

Modern brick construction. ANON. *Brick Clay Rec.*, **79** [9], 410–11 (1931).—Examples of interesting brick construction illustrated are the First Plymouth Church of Lincoln, Neb., in which clay roofing tile are used, the Moody Memorial building, Chicago, and the Western Union Telegraph Co.'s new building in Boston, Mass. The salient features of each are described. E.J.V.

A modern tile plant. JEAN VON GUNTEN. *Rev. mat. constr. trav. pub.*, No. 263, pp. 145–50*B* (1931).—The factory of Louis Gasser at Rapperswil, Bern, Switzerland, is described and illustrated. M.Y.H.

Standardization of drain pipes. ANON. *Tonind.-Ztg.*, **55** [83], 1161 (1931).—A review is given of the new German standard specifications for drain pipes concerning quality, dimensions, strength, and testing methods. W.M.C.

Ancient history. MARTIN HUBER. Translated from *Deutsche Ziegel-Zeit.* by W. D. RICHARDSON. *Clay-Worker*, **96** [4], 228–29 (1931).—The brickwork and architecture of the ancient civilizations of the Assyrians, Babylonians, Egyptians, and Romans are discussed and the characteristics of each are briefly enumerated. The kilns used by some of these people are described. E.J.V.

PATENTS

Hollow building block. VERN A. BARNHART. U. S. 1,829,435, Oct. 27, 1931. A hollow building block for end-set construction comprising a shell dimensioned in proportion to standard brick sizes and a double web dividing the shell to form vertical cells, the web being provided with a cleavage opening, the web and cleavage opening being located at a distance from one end of the block substantially equal to one-third of the complete block length whereby the block may be divided into two sections, one of which is substantially half the length of the other and both of which correspond substantially to at least one dimension of the standard brick sizes, the web and cells forming an easily gripped portion whereby it may be grasped with one hand for placing it in end-set position.

Brick-wall construction and brick. CLARENCE A. WILLSON. U. S. 1,832,074, Nov. 17, 1931. A brick-wall corner composed of a combination of standard brick and special brick having lugs on their back faces and constructed with two stiffening ribs inwardly extending in angular relation to one another near the corner, each rib being composed of a vertical row of lugs on the backs of special brick laid in a single wall, there being no direct connection between the two ribs.

Treating or dressing clay slab with sand, etc., in the manufacture of brick, etc. H. H. BAILEY AND J. E. BAILEY. Brit. 358,296, Oct. 14, 1931.

Flangeless stoneware or concrete drain or sewer pipe. FLANGELESS PIPE CO., LTD. Brit. 358,595, Oct. 21, 1931.

Refractories

Refractory materials. Examination of refractories in the laboratory. COLIN PRESSWOOD. *Metallurgia*, **3** [18], 223–25 (1931).—It is important to distinguish "apparent" and "true" (or powder) density. Production of refractory brick of low porosity is difficult. Silica brick have a porosity of 23 to 35%; this is lowered to 17% by careful grading, blending, molding, and firing. Refractory minerals undergo a permanent change in volume when heated, *e.g.*, magnesite and silica. The true density gives indications of the extent to which silica has been inverted into cristobalite

and tridymite. An underfired silica brick contains a large percentage of unconverted quartz which, in use, will be inverted and expand. Micro-examination gives the amount of tridymite present. Magnesite, when dead burned, inverts to periclase of density about 3.6. Density (and porosity) offers a guide to the service value as to slag resistance and spalling, and in some types of material it indicates the liability to permanent volume change. Each mineral has a characteristic thermal conductivity but is modified by porosity, fluxes, etc. A table shows the conductivity of various brick at various temperatures. Conductivity has a distinct influence on spalling. Refractories are good electrical resistors at moderate temperatures but show a big drop at 1400 to 1500°. Chrome brick have poor resistance. Pure silicon carbide, first-grade fireclay brick, bauxite brick, and lime-bonded silica brick have shown regular resistance curves. Diepschlag and Wulfestieg (see *Ceram. Abs.*, **9** [6], 437 (1930)) found that (1) the addition of MgO, SiO_2, and CaO reduces resistance at 1100°C and 1250°C and increases resistance at 1400°C and 1550°C, (2) the addition of Fe_2O_3 and Mn_3O_4 reduces resistance at all temperatures, (3) fine grain size and increased pressure reduce resistance, and (4) unstable mineral systems show most irregular results. Brick are made up of coarse grains cemented together by semifused "glass" which often is highly sensitive to temperature changes and cannot withstand expansion stresses if applied suddenly. Spalling is mainly due to (1) variable expansion of the material even when the temperature rises uniformly, (2) amount of "glass" present, its ability to withstand stress outwardly imposed, and its sensitiveness to temperature changes, (3) uneven temperature in the brick, and (4) freedom of the brick to expand. By far the greatest damage is done below 1100°C. Above this temperature the "glass" begins to soften and the viscous material produced allows the expanding particles to adjust themselves. The spalling tendencies can be modified by (1) grading and blending, (2) control of firing rate, (3) providing "expansion joints" equal to the total reversible expansion of the wall, and (4) heating all parts of the furnace wall simultaneously. There is no accurate index figure of "spallibility" or a standard test of slag resistance due to the difficulty of reproducing all the factors contributing to the destruction of slag. See also *Ceram. Abs.*, **10** [10], 706 (1931). M.V.K.

Special refractories for metallurgical research. D. TURNER. *Trans. Faraday Soc.*, **27** [3], 112–24 (1931); *Refrac. Jour.*, **7** [6], 328 (1931); *Stahl Eisen*, **51** [18], 563 (1931).—The following topics are discussed: (1) aluminous clay mixtures, (2) clay crucibles (25% pure Al_2O_3 with 75% china clay) for use at high temperatures, (3) high temperature gas-tight muffles (20% Al_2O_3, 80% china clay) cast and fired to 1500°C, (4) glaze for the muffles (40% china clay, 30% quartz, and 30% feldspar) fritted before use, then ground and made into a slip with 5% china clay, and sprayed into the muffles which are fired to 1610°C, and (5) silicon carbide clay mixtures, cast from slip with 70% of the carbide (40-mesh). Mixtures of 60% silicon carbide and 40% china clay fired to 1480°C are suitable for sleeve blocks, recuperator tubes, gas burners, etc. High mechanical strength, good thermal conductivity, and resistance to severe temperature changes and temperature gradients are characteristics of this material. For higher temperatures a mixture of 95% silicon carbide and 5% china clay is satisfactory. Methods of forming crucibles from pure oxides (Al_2O_3, Cr_2O_3, MgO, and CaO) are described. Additions of CaF_2 produce strong crucibles. Acid-treated Al_2O_3 makes better casting slip than the untreated. Thoria and thoria-lined crucibles and melting in high-frequency furnaces are discussed. For producing protection tubes for thermocouples, a special extrusion machine was devised. Cellulose acetate solution is used as a bond with nonplastic refractory materials. A description is given of making protective sheaths of ball clay-alumina mixtures and of lime-alumina mixtures. By the use of CaF_2 it is possible to produce gas-tight tubes which will resist corrosion. Tubes

of pure Al_2O_3, glazed by fusing the surface with oxyhydrogen flame, are almost impervious to gases. G.R.S.

Tests on refractories. CH. MEURICE. *Ind. chim. belge*, **1** [5], 203–12; [6], 253–68 (1930); *Chim. & Ind.*, **24** [4], 882 (1930).—The most important tests are dilatation and deformation under load. Fusing tests are made on samples shaped like Seger cones made from powder of the sample mixed with starch. It is important to increase the temperature progressively from 5 to 10° per min. beginning at 1400°F to obtain constant results. Theoretically, there are 2 softening points in the SiO_2–Al_2O_3 system: one at 1545°, the other at 1810°. In practice these points are lowered by impurities. The beginning of softening is not noticeable during the heating of a refractory because the fusible ingredients are generally present in small quantities and consequently the sample does not lose its shape. In fusing tests under load the beginning of the liquid phase corresponds to the beginning of the deformation of the sample. The degree of firing of silicate materials can be ascertained from the dilatation tests because of variations of the dilatation of silica. This test is made on the Chevenard dilatometer. It is possible to determine the varieties of SiO_2 present in the brick from the anomalies in the firing curve. The amount of swelling or shrinkage after firing indicates the degree of firing and whether or not the quartz is totally transformed. Silica brick show a strong anomaly at 250° (tridymite and cristobalite) and resist changes in temperature well between 1500° and 250° but will break when they are suddenly cooled from 250 to 100° (the heat of a match may suffice). A well-fired silica brick must have a density of 2.35; that of industrial products varies from 2 to 2.3. Quartz has a density of 2.65, cristobalite 2.32, and tridymite 2.26. Cold compression tests are seldom made. Heat tests are important for products having to bear heavy loads. Stability to chemical and fusing agents is ascertained by heating the brick in the presence of slag or corrosive products to which the brick will be exposed. The coefficient of thermal conductivity is given by the formula, $K = \frac{Q \times E}{T_1 - T_2}$; where Q is the quantity of heat transferred per second through the wall per unit of surface, E is thickness, and T_1 and T_2 are exterior and interior temperatures. There is no good method for making this determination. M.V.K.

Refractories in boiler-house practice. A. N. BASSETT. *Eng. Boiler House Rev.*, **44** [12], 774–80 (1931); *Sprechsaal*, **64** [36], 667 (1931).—Refractories for combustion chambers and similar parts of steam-boiler installations must have durability and strength. The life period depends on the capability of resisting scouring, slagging, and splintering off. With the high speed of fire gases, hard particles of the ashes erode the brick. The hardness of the brick and the kind of binding agent used are of great importance. In silica brick, clay shortens the life more than lime (although clay-bonded brick splinter less than lime-bonded). An addition of 0.2% sodium silicate to the clay was found advantageous. Instead of lime binding agents, numerous other substances, *e.g.*, calcium chloride, magnesium chloride, water glass, and alum can be used. Sulphite liquor also produces good results and improves the edges of the brick. Porosity is an important factor in the capability of resisting slag and a dense nonporous layer stops erosion. Silica brick in furnaces heated by generator gas are destroyed chiefly by light ashes contained by the gas. Great damage is produced by slagging. Ashes contained by the firing gases may considerably lower the softening point of silica brick through their alumina content and the only remedy is a protective coating with a high melting point. Grog brick are more refractory the more they approach pure aluminum silicate. Brick with 45% alumina content are the least affected by temperature fluctuations, whereas those containing 30% alumina are rapidly destroyed. The alkali and iron oxide contents are also of great importance. Grog brick with a high

iron oxide content, however, may be sufficiently refractory for moderate temperatures, although much depends on the distribution of the iron oxide. With a reduced atmosphere, corrosion is rapid but diminishes in proportion to the degree of acidity of slag. Viscous slag is considerably less active than liquid. Ashes containing calcium phosphate greatly corrode ordinary refractory clay. Coal rich in sulphur produces a thin and homogeneous coating on brick which causes erosion. With oil firing, greater difficulties arise from splintering than from slagging, especially when salt is present in the oil. Oil from Calif., Tex., and Okla. contains little iron and aluminum but noticeable quantities of vanadium and nickel. The strength of refractories is greatly diminished at high temperatures through the attack of slags. Silicon carbide blocks reduce the solid adhesion of slag and are used especially along the fire line, but are rapidly eroded by coal ashes with more than 8 to 10% iron if these are fused by flames under pressure. Silicon carbide blocks were found valuable for furnaces burning dust. The splintering of fragments from the surface is not caused only by sudden temperature changes, although these have a certain effect. A vitrification of the end of the brick can be caused by high temperature or slag, in which case the section between the vitrified and unchanged part is a weak point for attack. Splintering in arches can be caused by errors in construction (insufficient regard to expansion) or by underfired brick. Grog brick splinter less than silica products in which interior tensions developed from changes in their physical state. In siliceous clays, the firing temperature is important. In the same clay, firing to cone 10 can produce an irregular expansion curve, while this may become flatter if the same clay is fired to cone 20. Silicon carbide has a straight expansion curve in the whole zone from 0 to 1700°C. Grog brick with an average or a high content of alumina shows a small and uniform expansion at temperatures up to 1300° where they contract. With repeated heating to high temperatures and cooling in air, a loss in resistance to pressure occurs, whereas a material with a high silica content and clay binding (which does not have a high strength at first) preserves its original strength much better than that of a refractory clay. Splintering can also be caused by injuring the brick during the removal of slag. The strength of the material at temperatures at which it will be used is important. In silica brick this is simpler than in grog brick in which the effect of the grog powder addition is seen. Grog brick under charge at high temperatures may fail because of a defective cohesion between the grog powder and the other material or because of a softening of the binding mass. Thinner grog powder produces greater mechanical strength and better capability of resisting corrosion. The greatest resistance to pressure of grog brick is between 1000° and 1200°, and of silica brick, between 1500° and the highest attainable temperatures. Silica brick are softer at 200° than at any other temperature under 800°. In silica-alumina materials, the capability of resisting charge at higher temperatures can be increased by firing to higher temperatures. M.V.K.

Behavior of refractory linings in metallurgical kilns. F. NIEBLING. *Giesserei-Ztg.*, **18** [7], 144–46 (1931); *Chim. & Ind.*, **26** [3], 592 (1931).—The durability of a refractory lining depends on its resistance to mechanical, thermal, and chemical influences. These factors act simultaneously and are the cause of disagreements between practice and laboratory tests. The influence of high temperatures is seldom the origin of a premature destruction of the refractory. A typical property of grog brick is deformation under charge at high temperature; this can be alleviated by using grog brick having a degree of refractoriness 2 or 3 Seger cones higher than that of the maximum temperature they will have to sustain. The increase in temperature causes a dilatation which reaches a maximum at 1300°. Softening begins at 1450°. It is known that porous brick with large grains resist temperature changes well and are durable, but this advantage is lost in cupola furnaces because of the corrosion by slag and

fused metals, especially when different compositions are fused in the same furnaces. M.V.K.

Silica and magnesium brick. ANON. *Jour. four élec.*, February, 1930; *Ind. chim.*, **17** [203], 860 (1930).—Refractory brick used in metallurgical kilns must have a refractoriness not lower than 1500°, and conform to certain requirements of resistance and conductivity. Silica brick are discussed. Acid gases, oxygen, carbon, and reducers do not affect these brick but they have poor resistance to basic slag and oxides. Magnesium brick are described. The fusing point of magnesium brick is very high (2100° and 2200°). They are inert to chemical action even at high temperatures, but their softening temperature under charge is much lower. They are more refractory and more durable than silica brick but are more brittle and are not stable to temperature variations. M.V.K.

Magnesite as a lining material for cement kilns. K. A. GOSLICH. *Tonind.-Ztg.*, **55** [77], 1081–82 (1931).—The use of magnesite brick as a lining for cement kilns was not considered as practical up to now. Experiments point, however, to the fact that well-sintered magnesite will not react with the cement. The strength of a mortar made from cement and magnesite was found to be not much lower than the strength of a pure cement. No blowing was observed in these experiments. W.M.C.

Spalling of magnesite brick. COLIN PRESSWOOD. *Refrac. Jour.*, **7** [10], 451 (1931).—In a comparison of seven types of refractories, magnesite is the most liable to spall. Relative figures are as follows: silicon carbide 2, bauxite 13, zirconia 16, fire clay 3 to 30, chromite 42, silica 75, and magnesite 100. The spalling of magnesite walls has been reduced by (1) setting the brick dry or with oil or tar joints, no water being used and in many cases no cement; (2) provision of adequate expansion joints; (3) insulation; (4) the use of brick which, while made from typical iron-containing magnesite, are made by hand from coarse-grained plastic batch instead of by high pressure applied to fine graded material; and (5) eliminating all brick which are soft or underfired, as judged by fracture. A possible explanation of this spalling lies in the fact that the "matrix" which cements individual grains of a magnesite brick together may be "inelastic" or may, of itself, be highly sensitive to temperature changes. E.P.R.

Using magnesite in kilns fusing copper in the Krassny Vyborjets works. D. D. VOIEIKOV. *Tsvetn. Metally*, **5** [7], 1039–48 (1930); *Chim. & Ind.*, **25** [3], 618 (1931).—The advantage of magnesite over Dinas brick, clay, and quartz is its resistance to basic slag in fusion. It was used with success for walls and arches in kilns refining copper. Its weak points are its sensitivity to temperature changes and dilatation. Dilatation of magnesite occurs in a continuous manner but only during cooling. The apertures must therefore be carefully luted and the kiln cooled slowly when work ceases. An experiment was made to combine magnesite with Dinas brick. An intervening layer of chromite was found unnecessary. To assure strength, the kiln walls were slightly inclined. The thickness of the walls was equal to two brick: a magnesite brick in the interior, then a half Dinas brick, and a half clay brick. M.V.K.

Progress in refractory materials. ANON. *Manchester Guardian Comm.*, **9** [24], 290 (1931); abstracted in *Refrac. Jour.*, **7** [10], 472 (1931).—A general account is given of the recent progress made in magnesite refractories. The properties of magnesite brick of various compositions have been studied, showing that certain properties of the brick are those of the bond rather than those of the magnesia. The results of recent researches are summarized, particularly those of Hirsch on the softening range under load and of Miksch and Salmang (see *Ceram. Abs.*, **9** [7], 540 (1930)) on the slag-resisting properties of magnesite. E.P.R.

Refractories for induction furnaces. J. H. CLUSTERS AND W. J. REES. *Metal-*

lurgia, **4** [19], 21 (1931).—The lining must resist the steep temperature gradient between the molten metal and the water-cooled coil and be refractory and chemically resistant. Linings of magnesia were used in the original horizontal ring induction furnace. In the coreless furnace, fireclay and graphite crucibles have been used, but for the production of steel in quantity, durable linings of silica or magnesia with bonds such as boric acid have been developed. Besides refractoriness, other characteristics required are ability to sinter, corrosion resistance, and low firing shrinkage. The increased life of linings may be obtained (1) from the use of a purer or more refractory material, (2) by higher sintering temperature, (3) by a more refractory bond or the promotion of intercrystallization, either directly or by reaction with other materials, or (4) by shaped, tongued, and grooved brick which can be built into crucible form and can be patched with cement when worn. M.V.K.

Refractory materials for enamel plants. ANON. *Glashütte*, **61** [4], 58–60; [5], 76–77 (1931); *Feuerfest*, **7** [4], 61 (1931).—The basic conditions for choosing suitable refractory products for calcining kilns, muffle kilns, enamel fusing tanks and crucible kilns, generators, and recuperators are discussed. The economic use of silicon carbide, corundum materials, and coating masses is treated. M.V.K.

Refractories in steel works. K. ENDELL. *Jernkontorets Ann.*, **85** [7], 335–55 (1930); *Chim. & Ind.*, **25** [1], 118 (1931); for abstract see *Ceram. Abs.*, **9** [12], 1055 (1930). M.V.K.

Thermal expansion of silica mortars after firing at 950°C, 1200°C, and 1500°C. SANDFORD S. COLE AND DON C. LYNN. *Jour. Amer. Ceram. Soc.*, **14** [12], 906–12 (1931).

Thermal shock effect on the transverse strength of clay bodies. W. R. MORGAN. *Jour. Amer. Ceram. Soc.*, **14** [12], 913–23 (1931).

Steel-works refractories. R. H. STONE. Abstracted in *Refrac. Jour.*, **7** [10], 472 (1931); for abstract see *Ceram. Abs.*, **10** [8], 574 (1931). E.P.R.

High-temperature refractories. WM. H. SWANGER AND F. R. CALDWELL. Abstracted in *Refrac. Jour.*, **7** [10], 472 (1931); see also *Ceram. Abs.*, **10** [11], 784 (1931). E.P.R.

Structure and thermal conductivity of refractory brick. E. MAASE. *Stahl Eisen*, **51** [27], 860–61 (1931).—A short review is given on the values of thermal conductivity at temperatures up to 1000°C for different refractory materials. Nonmetallic amorphous substances show a low thermal conductivity which increases with rising temperature, whereas crystalline substances show a high thermal conductivity which decreases with rising temperature. The thermal conductivity decreases with increasing porosity, but the decrease is less at very high temperatures. Large pores conduct the heat better than small ones. The thermal conductivity increases with increased temperature while firing the refractory material. W.M.C.

Quality specifications for refractory linings. ANON. *Tonind.-Ztg.*, **55** [80], 1127 (1931).—The final German quality specifications for refractory linings cover refractory brick for blast furnaces and Siemens-Martin furnaces used in the steel production process. W.M.C.

Source of raw materials for high-temperature heat insulation. J. B. BARNITT AND R. H. HEILMAN. *Mech. World*, **90** [2336], 332–56 (1931); *Chem. Met. Eng.*, **38**, 390–93 (1931); *Proc. Eng. Soc. Western Pa.*, **47**, 349–71 (1931).—Pure alumina has a melting point of 3720°F, and therefore it may be expected that aluminous materials offer a promising field for investigation as possibilities for high-temperature insulation. This is true particularly because of the higher melting-point range, the lower shrinkage with increasing temperature, and the well-known refractory properties of alumina. The alumina obtained by extraction from aluminous ores by the Bayer and the fusion processes is of a high degree of purity and should resist temperatures up to 3600°F. Alu-

mina does not undergo crystalline transformations with consequent shrinkage or weakening until the temperature of recrystallization to corundum is reached. This temperature is considerably higher than the temperatures which insulating materials are required to withstand. E.P.R.

Melting of tool steel. J. P. GILL AND M. R. TREMBOUR. *Metal Prog.*, **20** [4], 73–76 (1931).—The hearth of the electric furnace used for melting tool steel must be of basic material, such as magnesite or burned dolomite, to withstand the lime slag used in the basic process. For the walls and roof, silica brick is used almost exclusively. The hearth may be rammed in by layers using a binder of sodium silicate, molasses, or tar and then fired in. E.P.R.

Carbonized fire clay. ANON. *Refrac. Jour.*, **7** [10], 452 (1931).—The following claims are made by the owners of Smiths Clay Carbonization Process who produce the raw material from which "S.C.C. Firebrick" are made. Brick made from fire clay which has been subjected to this process do not shrink in use, are quite stable in volume, will not spall or splinter, and are practically unaffected by sudden changes of temperature. As far as has been learned, carbonization effects little chemical change in the clay substance other than the changes which usually occur when clays are heated for long periods at high temperatures, such as the lowering by volatilization of the alkali and lime, etc., content, but there is an intense development of mullite crystals ($3Al_2O_3 \cdot 2SiO_2$). This fact is of great importance and largely explains the increased fire stability and high tensile strength of carbonized clay brick. Carbonized clay is made by an intimate mixture of finely divided carbon and fire clay which is obtained by mixing clay with any suitable liquid hydrocarbon and then heating the mixture to bright redness in the absence of much air. The oil or other hydrocarbon is decomposed, forming a fine black mass of carbon well distributed through the fired clay. When heated in an oxidizing atmosphere, "black carbonized" clay is converted into "white carbonized" clay; brick made from the latter are more porous than ordinary fireclay brick, but the pores are minute and the shrinkage, when the brick are in use, is practically negligible. Both black and white carbonized clay may be used in the manufacture of carbonized brick, carbonized crucibles, etc. E.P.R.

Gas permeability of refractories. H. IMMKE AND W. MIEHR. *Chem. Zentr.*, No. 2102 (1931); abstracted in *Refrac. Jour.*, **7** [10], 472 (1931); see also *Ceram. Abs.*, **10** [10], 705 (1931). E.P.R.

Expansion properties of refractories. F. GAMBEY AND G. CHAUDRON. Abstracted in *Refrac. Jour.*, **7** [10], 472 (1931); for abstract see *Ceram. Abs.*, **10** [10], 705 (1931). E.P.R.

Study of effect of grog on pressure transmission in dry pressing. C. M. DODD AND M. E. HOLMES. *Jour. Amer. Ceram. Soc.*, **14** [12], 899–905 (1931).

Proportioning the grain size in clay refractories. STEPHEN M. SWAIN AND STUART M. PHELPS. *Jour. Amer. Ceram. Soc.*, **14** [12], 884–98 (1931).

Refractories made from silicon carbide. ANON. *Sprechsaal*, **64** [43], 789–90 (1931).—Silicon carbide shows a high softening point at cone 40 (1920°C), high thermal conductivity, and great resistance against rapid temperature changes. Slags containing iron attack silicon carbide. A short outline is given on the manufacturing process of silicon carbide. The amount of clay added to the body varies from 10 to 20%. W.M.C.

Andalusite as a refractory. F. H. RIDDLE. *Trans. Electrochem. Soc.*, pp. 1–16 (1931); *Refrac. Jour.*, **7** [9], 436 (1931); for abstract see *Ceram. Abs.*, **10** [12], 845 (1931). E.P.R.

Action of slags on firebrick and boiler-furnace settings. T. A. KLINEFELTER AND E. P. REXFORD. *Trans. A.S.M.E.*, **53** [14], 301–305 (1931).—The results contained in

this paper were obtained in an investigation conducted by the Columbus branch of the U. S. Bureau of Standards for the A.S.M.E., Special Research Committee on Boiler Furnace Refractories. The paper presents a rational discussion of the action of coal ash upon boiler-furnace refractory walls and shows the consistency of results from the authors' laboratory slag tests with fire brick under actual service conditions in boiler furnaces. See also *Ceram. Abs.*, **10** [6], 436 (1931). E.P.R.

Comparative resistance of refractories to coal-ash slag. R. K. HURSH. *Trans. A.S.M.E.*, **53** [14], 297–300 (1931); for abstract see *Ceram. Abs.*, **10** [9], 644 (1931). E.P.R.

Influence of iron oxide on sintering and some important properties of dolomite used in steel plants. OTTO KRAUSE AND HERMANN GUHR. *Feuerfest*, **7** [9], 129–36 (1931).—The influence of iron oxide on the sintering and deformation of dolomite refractory blocks is discussed on the basis of ceramic and physical tests. M.V.K.

Furnace-gas compositions and temperatures in underfeed stoker-fired boilers, and their effect on boiler settings. ALBERT C. PASINI AND EDWARD M. SARRAF. *Trans. A.S.M.E.*, **53** [14], 315–33 (1931); for abstract see *Ceram. Abs.*, **10** [12], 846 (1931). E.P.R.

Classification of graphite according to the method of combustibility. N. CHIZHEVSKI AND E. KRASSAVIN. *Vestn. Metalloprom.*, **10** [9–10], 192–96 (1930); *Chim. & Ind.*, **25** [6], 1447 (1931).—Graphite differs in chemical and physical properties. The reactivity indicates the technical value of graphite and permits the classification. The action of carbonic gas was studied on 3 different kinds of graphite from 500 to 1200° and it was found that the reactivity of amorphous graphite is considerably superior to that of crystalline graphite; it approaches the reactivity of blast-furnace coke. M.V.K.

Rotary kiln for extracting aluminum salts from clay. L. WASILEWSKI AND J. Z. ZALESKI. *Ind. chim.*, **17** [200], 629 (1930); for abstract see *Ceram. Abs.*, **9** [8], 651 (1930). M.V.K.

Titanium content of bauxites. JACQUES DE LAPPARENT. *Compt. rend.*, **190**, 1312 (1930).—Bauxite of France runs from 3 to 8% titanium and even as high as 12%. It is present generally as ilmenite, rutile, or anatase. Where rutile and anatase occur they are generally the result of deferrification of ilmenite. In some bauxites from India, small crystals of anatase or rutile are found together with unchanged ilmenite. Generally rutile and anatase occur as fine crystals, but occasionally large ones occur. R.H.E.

Furnace walls. III. GEORGE P. REINTJES. *Blast Fur. Steel Plant*, **19** [10], 1386 (1931).—Though the art of building a wall of brick or tile was developed in early times, there has been very little change made in the method of construction. R. discusses the general practice in plants in regard to furnace-wall construction and repair. **IV.** *Ibid.*, **19** [11], 1494 (1931).—The way production per mason is controlled by the union rule prohibiting a mason laying a brick above the course where the line is stretched and the speed of the mason building the corner "leads" is explained, and a simple method of speeding up the production per man by placing two refractory tile at the angle of a furnace or tank so as to do away with the man working on the "lead" is described. Illustrated. For Part II see *Ceram. Abs.*, **10** [11], 783 (1931). E.J.V.

Refractories and their uses. P. F. THOMPSON. *Chem. Eng. Mining Rev.* [Australia], **23**, 455–59 (1931).—Refractories are homogeneous or heterogeneous, the latter being an aggregate with properties which may be additive or compensating. The present condition of refractories testing is regarded as similar to that of metals before the microscope was used. H.H.S.

Refractory materials recent examinations. ANON. *Refrac. Jour.*, **7** [10], 450 (1931).—It is well recognized that knowledge of the characteristics of refractory

materials is an essential part of the intellectual equipment of the metallurgist and fuel or glass technologist. At the University of Sheffield the study of refractory materials is an integral part of the courses leading to a degree or associateship in metallurgy, fuel technology, and glass technology. E.P.R.

Advance in the refractory industry of the U.S. in 1930. W. STEGER. *Feuerfest*, **7** [4], 49–56 (1931).—S. discusses (1) raw materials, (2) shaping of refractories, (3) methods of investigating properties of refractory raw materials and objects, (*a*) chemical analyses, (*b*) resistance to pressure at room temperature, (*c*) thermal expansion, (*d*) resistance to sudden temperature changes, (*e*) resistance to abrasion at high temperatures, and (*f*) strength of refractory mortars, and (4) refractory products in the glass industry. M.V.K.

Fifty years of scientific research in the refractory industry. W. MIEHR. *Tonind.-Ztg.*, **55** [78], 1093–96; [79], 1115–16; [81], 1136–37 (1931).—This paper was read during the jubilee meeting of the German Assn. of Refractory Mfrs. and gives a review of the scientific progress during the past fifty years, dealing mainly with the refractory industry. W.M.C.

Economical situation of the German refractory and clay industries. G. PLUM. *Tonind.-Ztg.*, **55** [77], 1085–87 (1931). W.M.C.

British Industries Fair. ANON. *Metallurgia*, **3** [16], 121–26 (1931).—Among different tools exhibited in Birmingham were samples of refractory products including (1) special refractory for frit kilns and enamel melters, (2) silicon carbide and corundum panel brick for muffle linings, (3) sillimanite brick and tile and electric heat-treatment specials, (4) cement furnace blocks in aluminous and sillimanite materials, (5) silica specials for gas-making and coke-oven installations, (6) panel brick and silica shapes used in heat-treatment furnaces and enameling furnaces, and (7) samples of superjointing cements for the cementing of brick of all compositions. All these refractories are classed according to definite compositions and each has its special use, *e.g.*, the aluminous brick withstand the severest conditions and temperatures, corrosive dust action, and penetrative slag action. Sillimanite brick are resistant to soda, lime, etc., but not to iron oxide or other molten metallic oxides. "Alcor" corundum brick are resistant to all the fusible oxides often found in fuel ash. See also *Ceram Abs.*, **10** [6], 467 (1931). M.V.K.

BOOK AND BULLETIN

Modern Treatise on Refractories. F. H. NORTON. Price $6.00. 600 pp. Reviewed in *Ceram. Ind.*, **17** [5], 414–16 (1931); *Brick Clay Rec.*, **79** [8], 366 (1931).—This book covers such subjects as the history of refractories development, refractory clays, mining of materials, molding, drying, firing, melting points of refractories, load-bearing capacity, spalling, the microscope and its uses in the study of refractories, use of X-rays, etc. The fundamental processes involved in the manufacture and use of refractories are discussed. E.J.V.

Bauxite and aluminum in 1929. C. E. JULIHN. Bur. Mines, *Mineral Resources U. S.*, 22 pp. (1929). 5¢. R.A.H.

PATENTS

Glazing refractory articles. GRANT S. DIAMOND. U. S. 1,828,767, Oct. 27, 1931. A process of impregnating porous articles with a glazing solution including subjecting the articles while hot to a solution of the glazing composition at an elevated temperature but below the boiling point of the solution, the solution being saturated with the glazing material and containing glazing material in suspension when the article is subjected thereto.

Mold for casting refractories. FREDERIC W. SCHROEDER. U. S. 1,829,114, Oct.

27, 1931. The combination of a mold composed of baked slabs, of a flask within which the mold fits, and a layer of freely flowing sand approximately one-eighth inch thick interposed between the slabs and the inner surface of the walls of the flask.

Crucible-furnace lining. HAROLD E. WHITE. U. S. 1,829,320, Oct. 27, 1931. A crucible melting furnace comprising a casing open at the top and a lining for the casing, the casing having a bottom supporting the lining and adapted to support a crucible, the lining comprising superposed rings of refractory material insertable through the top, one of the rings and side walls of the casing having a burner opening and a slag opening therethrough, and the rings having their bores of the same diameter and with the walls thereof in flush relation, the lining thus avoiding laterally separable sections and affording a substantially smooth and uninterrupted surface for the passage of the gases of combustion thereover.

Furnace-wall lining or facing. GEORGE P. CRYSLER. U. S. 1,830,384, Nov. 3, 1931. A wall structure including a wall formed from block units, the blocks having horizontally disposed recesses in their back faces, the blocks having horizontally disposed inwardly extending channels in the front faces thereof near the upper ends and horizontally disposed recesses in the front wall below the channel, facing blocks of similar outline but of less area having projecting noses on the rear faces near the top of the blocks, the noses arranged for entering the channels in the first-mentioned blocks, the channels and the noses having interfitting engagement to prevent lateral displacement of the second-mentioned blocks, the faces of the second-mentioned blocks coöperating with the horizontally disposed recesses in the front faces of the first-mentioned blocks for providing air passages, both of the blocks having vertically disposed apertures communicating with the passages.

Furnace wall. LEWIS W. HELLER. U. S. 1,830,655, Nov. 3, 1931. In a furnace, a wall section and a second wall section above the first-named wall section, one of the wall sections being movable relative to the other and adjacent portions of the wall sections forming a space downwardly inclined toward the furnace to prevent ash or clinker from collecting between the wall sections.

Heat-exchange device. NORMAN HUBBARD. U. S. 1,831,533, Nov. 10, 1931. In a heat exchanger, plates spaced to form alternate passages for hot gas and air, separators located in alternate spaces between the plates, and elongated clamps with spacing members thereon extending transversely of the plates across a plurality of them to clamp each pair of plates to the separators between them.

Furnace wall. JASON A. LODWICK. U. S. 1,831,675, Nov. 10, 1931. A furnace wall comprising a supporting structure and a refractory block lining bonded thereto and having means forming by-passed joints and air-channel means behind the joints.

Making silicate-bonded material. LAWSON L. WAGNER. U. S. 1,831,982, Nov. 17, 1931. The process of producing bodies containing united particles of kieselguhr which comprises confining a compact mass of a mixture of an oxide of an alkaline-earth metal and kieselguhr in a steam-permeable mold and subjecting the contents of the mold, while in the compact condition and substantially free from any expansion in the mold, to the action of steam at such a temperature as to promote the formation of an alkaline-earth silicate.

Sagger. ROBERT E. ANDERSON. U. S. 1,832,442, Nov. 17, 1931. A sagger formed from refractory material and comprising a base provided with apertures adjacent its opposite ends and end members each provided with a tenon at one end and having a recess formed in its opposite end, the end members extending vertically from the base and being retained in position through engagement of the tenons in the apertures.

Manufacture of silica-alumina refractories. PAUL G. WILLETTS. U. S. 1,832,678, Nov. 17, 1931. A process of making refractory objects which comprises grinding to

impalpable fineness natural starting material, at least approximately 96% of which is composed, on dry analysis, of silica and alumina accompanied by not more than 1½% of iron oxide and alkalis, forming a grog material by intimately mixing the impalpably fine starting material in the presence of water, calcining the grog material to a temperature at least as high as 2700°F, breaking down the calcined material to form grog, mixing the grog with raw material of the above-stated composition, pressing the assembled material into objects in the presence of not more than 12% of water, the pressing pressure being applied in a plurality of stages between which the pressure is relieved, and the material being contained, while being pressed, in a mold which is free to float in the line of the application of pressure, and subjecting the objects to a temperature at least as high as 2700°F for a sufficient time to bring the whole mass of each object to the firing temperature, thus developing, within the objects, microscopic crystals, typically of aluminum silicate, accompanied by a highly viscous glassy matrix, and destroying the original identity of the starting materials.

Manufacture of refractory articles. CARBORUNDUM CO., LTD. Brit. 357,611, Oct. 7, 1931.

Manufacturing refractory materials. W. W. TRIGGS. Brit. 358,690, Oct. 21, 1931.

Terra Cotta

Formation of blisters in stoneware products. W. SCHUEN. *Tonind.-Ztg.*, **55** [84], 1172–73; [85], 1187 (1931).—(1) With well-prepared bodies, blisters are developed only near the surface, whereas poorly mixed bodies may show blisters throughout the entire structure. (2) Blisters will readily form if the products are fired at too high a temperature. Therefore only clays with a high melting point and long heat range should be used. The reasons for the formation of blisters are reactions of iron oxides and carbon together with the presence of sodium oxide. Some samples of blistering stoneware products are illustrated and chemical analyses are given. See also *Ceram. Abs.*, **10** [2], 116 (1931). W.M.C.

Faults in the manufacture of stoneware pipes. W. SCHUEN. *Tonind.-Ztg.*, **55** [74], 1043–44 (1931).—The main faults encountered in the manufacture of stoneware pipes are briefly discussed. W.M.C.

Acid-resistant stoneware. GENERAL CERAMICS CO. *Brass World*, **27** [10], 222 (1931); for abstract see *Ceram. Abs.*, **10** [10], 739 (1931). E.P.R.

Machine-made terra cotta graduates out of "specialty" class. ANON. *Brick Clay Rec.*, **79** [9], 393–94 (1931).—Several Pacific Coast terra cotta plants are manufacturing terra cotta on sewerpipe presses, using a somewhat denser clay mixture than that used for hand-made terra cotta. The present practice is to use a die that turns out a hollow column reinforced inside by one to three lineal partitions. About 5000 lineal feet can be turned out by one press in a day. Shapes with smooth, ribbed, and corrugated faces, returns, reveals, jambs, and sills, as well as ashlar, have been turned out. The major feature of the machine-made product is the extreme thinness of the section. Illustrated. E.J.V.

Color treatment of architectural trends. ANON. *Brick Clay Rec.*, **79** [9], 409 (1931); abstracted from *The Economist* and *Magazine of Wall Street*.—The use of the services of a color expert to bring more color into buildings and some of the new buildings in New York which have been erected as outstanding examples of color in architecture are discussed. E.J.V.

German standard specifications for flowerpots. ANON. *Tonind.-Ztg.*, **55** [82], 1150–51 (1931).—Standard dimensions are given which are proposed for flowerpots. W.M.C.

The Field Museum and Oxford University joint expedition at Kish. II. HENRY FIELD. *Art & Arch.*, **31** [6], 323–24 (1931).—Illustrations of a polychrome terra cotta head and several jars and bowls excavated at Kish are given. See also *Ceram. Abs.*, **10** [2], 95 (1931). E.B.H.

BOOK

Roof Tiling. C. G. DOBSON. With foreword by Edwin Savill. xvi + 147 pp. Crosby Lockwood, London, 1931. Price 12s 6d. Reviewed in *Times Lit. Supp.*, **30**, 668 (1931).—D. gives a short history of the craft and an outline of modern methods of manufacture, and illustrates the differences between various tile, etc. H.H.S.

White Wares

Manufacture of bone china. HAROLD J. PLANT. *Pottery Gaz.*, **56** [652], 1393–94 (1931).—Of all the different kinds of pottery bodies, the so-called bone-china body is probably the most remarkable. From the time the raw materials enter the blunger to the time the finished ware leaves the glost kiln, the bone ash is the seat of a number of extraordinary chemical changes which make the chemistry of the body unique. Among the loss-producing faults commonly experienced among bone-china manufacturers are brown discoloration, or "rinderpest," crooked china, black specks associated with underglaze printing, frizzling of decorations in the glaze kiln, unstable kiln colors, bursting of hollow ware during the biscuit firing, pinholing, etc. The slightest strain caused during the making of bone china has a tendency to develop and become accentuated during the firing. Tests on a special impact machine have shown English bone china to be two to three times stronger from the standpoint of fracture-resistance than earthenware, and 75% stronger than the best Continental hotel china on the market. Need of further study to improve the quality of colors on bone china is pointed out. Troubles in connection with powder-blue and underglaze decorations have been overcome by a change to smaller kilns of a new construction. E.J.V.

Presence of cobalt and manganese in different kaolins. M. LARCHEVÊQUE. *Céramique*, **33**, 221–22 (1930); *Keramos*, **10** [19–20], 507–508 (1931).—L. discusses kaolins containing large quantities of cobalt oxide and manganese oxide, *e.g.*, asbolane with the formula $CoO{\cdot}2MnO_2{\cdot}4H_2O$, and refers to the addition of cobalt to obtain blue-white glazes and engobes in the manufacture of sanitary stoneware and faience. It is possible that the special white color of kaolins containing cobalt can be traced back to a similar action of blue. M.V.K.

Progress report on investigation of sagger clays. VI. The life of the sagger as affected by varying certain properties. R. A. HEINDL AND L. E. MONG. *Jour. Amer. Ceram. Soc.*, **14** [12], 867–76 (1931); for Part V see *Ceram. Abs.*, **8** [8], 590 (1929).

Effect of prolonged boiling, autoclave treatment, and drying on the water absorption of earthenware. ANON. *Jour. Frank. Inst.*, **211**, 515 (1931). J.T.L.

Sillimanite minerals as refractories. FRANK H. RIDDLE AND R. TWELLS. *Jour. Amer. Ceram. Soc.*, **14** [12], 877–83 (1931); *Brick Clay Rec.*, **79** [3], 130–34 (1931).

Revue of thousand cups. ANON. *Sprechsaal*, **64** [31], 586–87 (1931).—An exhibition of porcelain cups held in Berlin in June is described. The baroque, rococo, empire, and modern styles were displayed in cups. Cups made of "metal-porcelain," *viz.*, porcelain coated with nickel or copper and therefore not easily breakable, were also exhibited. Their chief advantage is that the liquid remains hot and keeps its original aroma for a longer time. M.V.K.

Educative trade display by pottery manufacturers. ANON. *Pottery Gaz.*, **56** [652], 1395–97 (1931).—A description of a display of china and earthenware conjointly pre-

sented by Paragon China, Ltd., Longton, and A. J. Wilkinson, Ltd., Burslem, is given. A special feature of the exhibition was a series of a dozen special table settings to show how pottery can be best utilized. Illustrated. E.J.V.

Porcelain and stoneware industry in Poland. ANDREW E. DONOVAN. *Commerce Repts.*, No. 42, p. 161 (1931).—Three of the largest factories in Poland, working full time, are capable of filling between 80 and 90% of the domestic demand. In June, 1931, the three factories founded a joint sales office under the name of Polska Porcelana (Polish Porcelain) to lower production costs and rationalize production. Porcelains of Polish production filled about 50% of local requirements during 1929, total sales being around 9,000,000 zlotys. In 1930 imports from Czechoslovakia increased about 30% and domestic production fell to about 7,000,000 zlotys. Most of the Polish factories are being operated at a loss. Of three important factories producing stoneware, two are closed and the third has reduced production to 50% of its capacity owing to Czechoslovakian and German competition. E.J.V.

Eighty porcelain works close in Japan. W. S. DOWD. *Commerce Reports*, No. 42, p. 161 (1931).—As a result of the economic depression, after trying production curtailment, wage reductions, and other economies, eighty porcelain factories at Seto, Nagoya Prefecture, Japan, shut down operations for three months beginning August 15. A fund has been raised to provide a living for the employees involved. E.J.V.

BOOK

Ten Generations of a Pottery Family. Compiled by ROBERT NICHOLLS, with a foreword by ALEYN LYELL READE. Percy Lund, Humphries & Co., Ltd., London. Price, 3s 6d net. *Pottery Gas.*, **56** [652], 1416–17 (1931).—The story is told of the early history of the old English potters and particularly of those matters which had a bearing upon the Adams family, who are shown to have been potting in North Staffordshire as early as 1447. Light is thrown upon some of the old customs in the pottery trade and some of the old terms employed are explained. E.J.V.

PATENTS

Feeding and forming plastic material in the manufacture of pottery. WILLIAM J. MILLER. U. S. 1,827,759, Oct. 20, 1931. In mechanism of the class specified, means for extruding a charge of plastic material into or on a mold and means for segregating and preforming the charge through rotation of the mold.

Insulator. VICTOR FREDERICK HOUDE. U. S. 1,829,354, Oct. 27, 1931. An insulator comprising a body provided with a projecting shoulder with a pair of spaced-apart lugs upwardly extending therefrom, the upper face of the shoulder forming a transverse wire-receiving socket intervening between the lugs and body, a clamp pivoted in the lugs and adapted to bear against a wire received in the socket, and a resilient locking member on the clamp engageable on the body.

Plumbing system. WILLIAM C. GROENIGER. U. S. 1,830,106, Nov. 3, 1931. A sanitary water-flushing receptacle having a rim and an upstanding extension extending above the level of the rim by means of which flushing water is distributed to the interior of the receptacle from a source of supply, the extension having an interior integral water-directing nozzle depending from the top thereof in concentric spaced relation to the inner wall of the extension to a plane above the overflow level of the rim, and a constantly open air port in the wall of the extension near the top and adjacent the side of the nozzle for obviating the possibility of the siphoning of the receptacle water back into the source of supply.

Water closet. JOHN C. DUNER. U. S. 1,831,528, Nov. 10, 1931. A water closet comprising a closet bowl supported above its outlet, a dump pan positioned beneath the

bowl and adapted to swing from a sealing position downwardly to a dumping position, a draft member located beneath the dump pan and arrangeable in a sealing position as an incident to the opening movement of the dump pan, and a dump-pan and draft-member operating mechanism comprising an arm and linkage mechanism connecting the dump pan and draft member and moved over center position into locking relation as the draft member moves to a sealing position.

Mop sink. THOMAS MASON. U. S. 1,831,966, Nov. 17, 1931. In a mop sink, a body having an upwardly extending apron at the rear thereof, inverted hollow-ribbed front and sides terminating at the lower outside ends in an outwardly directed horizontal supporting flange extending around the base and partly upward on each side of the body, the supporting flange being adapted to support the sink on a floor, and an outlet at the lower end of the body to adapt the sink to be connected to a soil pipe.

Insulator. CLOYD B. VAN ATTA. U. S. 1,832,157, Nov. 17, 1931. In an insulator, a porcelain body having an upstanding stem thereon and formed with a recess, a cap fitting upon and secured to the stem, and a pin cemented within the recess, the pin having a head formed with a flaring endmost step with a beveled and rounded edge, the pin being further formed with additional steps, the endmost step being of less diameter than the other steps.

Insulator pin. BENTLEY A. PLIMPTON. U. S. 1,832,240, Nov. 17, 1931. An insulator supporting pin comprising a one-piece seamless forged body member of tubular form having one end spun to provide an outstanding circular flange adapted to form a seat for engagement upon the top of a support, the other end being rolled to provide a thread for engagement within an insulator, and a bolt fitting snugly within the body and extending substantially throughout the length thereof and projecting beyond the flange.

Illuminating system for tile-mounting machines. LOUIS S. JONES, GARFIELD W. FISHER, NOBLE C. BUTLER, AND CARL G. HENRIKSON. U. S. 1,832,558, Nov. 17, 1931. A tile-treating machine comprising a conveyer for filled tile-mounting boards, curtains extending across the board, a source of light above the space between two curtains providing substantially direct vertical illumination for the tile between the curtains, one or more sources of light alongside the conveyer outside the space, and reflectors for determining the direction in which the light from the last-named sources falls on the adjacent tile.

Teapots. J. CHARTERIS. Brit. 358,404, Oct. 14, 1931.

Tea, etc., cups and saucers therefor. H. B. RONEY. Brit. 358,533, Oct. 21, 1931.

Teapots, coffee pots, and like pouring vessels provided with loose lids or covers. V. G. H. ALCOCK, W. LINDLEY, AND W. BLOORE. Brit. 358,746, Oct. 21, 1931.

Construction and fitting of lavatory basins, sinks, and baths. F. G. MANSFIELD. Brit. 359,129, Oct. 28, 1931.

Equipment and Apparatus

Optical pyrometer. ANON. *Chem. Met. Eng.*, **37** [2], 114–15 (1931).—Comparison is made with the filament of a small electric lamp placed between a wedge of smoked glass and the eye. Assuming that the brightness of the lamp filament is correct, the smoked glass wedge may be rotated until the apparent intensity of the radiating source is equal to that of the lamp filament. The new instrument, manufactured by the Pyrometer Instrument Co., is entirely self-contained, including a range-changing filter, small battery, an ammeter, and rheostat. A standard lamp is also supplied. G.R.S.

Optical pyrometer. ANON. *Chem. News*, **143** [3729], 222–23 (1931).—A brief description is given of the latest design of the "Foster" optical pyrometer. G.R.S.

New radiation pyrometer. LENNEL. *Arch. Wärmewirt.*, **12** [5], 154 (1931).—In the new radiation pyrometer, a bimetal spiral is exposed to the temperature radiation of the body to be studied. While being heated up, the spiral will move according to the different expansion of the two metals used. The temperature can be read immediately by means of a pointer and a scale. To compensate the influence of the room temperature, a second bimetal spiral is provided in the instrument. W.M.C.

Brinell, Rockwell, and scleroscope hardness of nonferrous metals. O. SCHWARZ. *Z. Metallkunde*, **22** [6], 198–202 (1930); *Metallurgia*, **3**, 109–12 (1931).—The application of these tests and a comparison of the results of tests on various nonferrous materials are reported. The relation between the Rockwell and the Brinell tests and between the scleroscope and the Brinell tests are discussed. L.T.B.

Contact pyrometers. W. CLAUS AND R. HASE. *Z. Metallkunde*, **23** [4], 120–23 (1931).—The technique for the determination of temperatures of solid bodies, in order to find the optimum working temperatures, has not received as much attention in the past as has the measurement of the temperatures of molten materials. Measurements of temperatures of solid bodies may be made by means of contact pyrometers. Such pyrometers are described and illustrated. The theory of the measurement of surface temperatures, the importance of such measurements in metal technical industries, the technique of such measurement, and the errors which may be introduced are discussed. Finally there are included some practical hints for the use of these instruments. L.T.B.

Pyro rapid recorder and radiation tube. PYROMETER INSTRUMENT CO. *Blast Fur. Steel Plant*, **19** [11], 1481 (1931).—Illustrated. E.J.V.

New Brown potentiometer pyrometer. T. R. HARRISON. *Instrument World*, **4**, 49–50 (1931); see also *Ceram. Abs.*, **10** [9], 652 (1931). H.H.S.

Temperature control of industrial furnaces by means of the "ardometer." W. LIESEGANG. *Arch. Wärmewirt.*, **12** [10], 293–95 (1931).—In the "ardometer" the radiant heat emitted is concentrated by means of a lens on a thermocouple contained in a glass bulb filled with noble gas. The hot junction of the thermocouple is broadened by means of a blackened platinum strip. Several possible uses of the ardometer with or without special protection devices and examples of measurements given as well as comparison between different types of pyrometers are described. See also *Ceram. Abs.*, **10** [8], 548 (1931). W.M.C.

High vacuum-pressure control apparatus. T. L. HO. *Proc. Nat. Acad. Sci.*, **17** [9], 548–50 (1931).—The apparatus consists of a reservoir connected by means of an electric mercury valve to the vessel in which a constant low pressure is to be maintained. The pressure is measured by a hot wire gage connected to a galvanometer which is used as a contact key operating a system of relays to open and close the electric mercury valve. A description is given of the mercury valve and a diagram is shown of the entire apparatus. Precautions in operation are mentioned. G.R.S.

Apparatus for the rapid determination of specific electrical resistance of conductor and resistance materials. H. VON STEINWEHR. *Z. Metallkunde*, **22** [5], 177–78 (1931).—Often in industry it is necessary to make many measurements of specific resistances. For great accuracy and speed it is not advantageous to make these measurements by means of the Wheatstone bridge or the Thompson double bridge. A compensator method is described in this article which serves to measure a considerable number of wires in one set-up. By means of this type of measurement the length of the wires is accurately determined. Diagrams of the set-up are included. L.T.B.

Theory and construction of the circular mass spectrograph. H. MURAWKIN. *Ann. Physik*, **8** [2], 203–60 (1931).—Mass spectrographs are used to study the isotopes of simple and composed substances. In this paper a survey is given of the theoretical

fundamentals for mass spectrographs which are discussed thoroughly. Different types of apparatus developed by several authors are reviewed and criticized and the data is compiled of a new circular mass spectrograph. The influence of horizontal and vertical scattering leads to a new formula for the dispersion. Formulas are given for the maximum intensity of the spectral lines and the influence of the slit size on the intensity is discussed. The new apparatus is furnished with an eccentric arrangement of the slits. The dispersion is found independent from the constants of the apparatus and may be increased according to the limit of the registering devices. W.M.C.

New gas-fired furnace fuses high melting-point metals. PALO-MYERS, INC. *Gas Age-Rec.*, **68** [19], 699 (1931).—A new high-temperature furnace for firing highly refractory products made from zirconium oxide, magnesium oxide, and aluminum oxide, and for melting and alloying platinum and other metals with a high melting point employs a style of "double flame conduction" which insures a more complete utilization of the heat contained in the combustion gases. Two cylindrical casings built concentrically one inside the other and made of a highly refractory material (magnesium oxide or zirconia) make up the inner portion of the furnace. Illustrated. E.J.V.

Science and practice of drying. VII. ANON. *Brit. Clayworker*, **40** [474], 240–43 (1931).—The old-fashioned method of drying brick and tile on hacks and its results in excessive damage and depreciation in quality of the ware are discussed. Modern methods of artificial drying, including drying sheds without heat as well as those making use of exhaust gases, steam, or hot water are also discussed. A brief discussion of Hooper's drying floor is included. For Part VI see *Ceram. Abs.*, **10** [12], 851 (1931). R.A.H.

Air-drying plants. G. SCHULZ. *Tonind.-Ztg.*, **55** [80], 1126 (1931).—Air-drying plants for brick, etc., are now being modernized by introducing automatic cars as used hitherto only in artificial drying plants. Different systems are outlined. W.M.C.

Measuring drying of clays and ceramic materials. P. FRION. *Keramos*, **10** [19–20], 511 (1931); for abstract see *Ceram. Abs.*, **10** [4], 285 (1931). M.V.K.

Study of apparatus for cutting brick, etc. P. RENAULT. *Rev. mat. constr. trav. pub.*, No. 263, pp. 150–52*B* (1931).—Grinder pug mills and purifying pug mills are described and their differences noted. Used in the treatment of stony clays, the former causes the incorporation of the stones with the clay, whereas the latter causes the elimination of the stones from the body. See also *Ceram. Abs.*, **10** [12], 851 (1931). M.Y.H.

Wire cutters in the brick industry. ANON. *Tonind.-Ztg.*, **55** [86], 1193–94 (1931). W.M.C.

Finishing apparatus for interlocking tile. H. DENDL. *Tonind.-Ztg.*, **55** [84], 1174–75 (1931).—A new finishing apparatus for interlocking tile is described which will substitute the work of four people. W.M.C.

Sand-blast abrasives. WILLIAM ASHCROFT. *Metallurgia*, **4** [22], 122 (1931).—Steel grit and shot are now being increasingly employed for preparing the surface of metals for electrolytic baths, for enameling, and for cleansing castings, because they last and cause little dust. M.V.K.

Simplified outflow-viscosimeter. F. ZAPP AND A. HEINZ. *Keramos*, **10** [21], 547–49 (1931).—A new outflow-viscosimeter of great exactness is described. It can be used for determining the casting capability of ceramic mixtures. M.V.K.

Two-roll vibrating screen possesses advantages. ANON. *Eng. Mining Jour.*, **132** [3], 129 (1931).—A new roll-type screen which prevents clogging of the rolls and avoids crushing of the material is described. C.R.A.

Rubber pipe lining minimizes pulp abrasion. D. D. HOMER. *Eng. Mining Jour.*,

132 [8], 367 (1931).—An example is given of the economy of using rubber-lined pipe for the transmission of abrasive materials. C.R.A.

Developments in the ceramic industry. ANON. *Ceram. Ind.*, **17** [5], 356–87 (1931).—A review is given of the developments in machinery, materials, and equipment of interest to ceramic products manufacturers that have taken place during the past twelve months. Sixty-nine items, each describing a new development, are included in the review. W.W.M.

What managers should know about power drives. I–VI. WILLIAM STANIAR. *Factory & Ind. Management*, **81** [3], 419–20; [4], 607–608; [5], 805–806; [6], 985–86; **82** [1], 57–58; [2], 181–82 (1931). E.C.C.

Saving of labor and power in brick plants. ANON. *Tonind.-Ztg.*, **55** [75], 1059–60 (1931).—Some mechanical means are reviewed and hints for firing of brick are given which will result in a saving of labor and power. W.M.C.

Preventing silicosis by collecting drill dust at its source. ANON. *Eng. Mining Jour.*, **132** [1], 16 (1931).—A new dust collector applied to air-hammer drills to prevent the siliceous dusts from escaping into the atmosphere is described. See also *Ceram. Abs.*, **10** [11], 791 (1931). C.R.A.

CATALOGUE AND BULLETINS

Chemical Engineering Catalog, 1931. Chemical Catalog Co., Inc., New York. 1017 pp., illustrated. Reviewed in *Can. Chem. Met.*, **15** [10], 50 (1931); *Mining & Met.*, **12** [299], 11 (1931).—This, the 16th edition, comprises collected, condensed, and standardized catalog data of equipment, machinery, laboratory supplies, heavy and fine chemicals, and raw materials used in the industries employing chemical processes of manufacture. E.J.V.

Method and cost of quarrying limestone and shale at the quarry of the Trinity Portland Cement Co., Dallas, Tex. J. WILLIAM GANSER. Bur. Mines, *Information Circ.*, No. 6498, 12 pp. (1931). (Free.) R.A.H.

Mining methods of the Molybdenum Corporation of America at Questa, N. M. J. B. CARMAN. Bur. Mines, *Information Circ.*, No. 6514, 15 pp. (1931). R.A.H.

PATENTS

Ceramic block-cutting apparatus. CHARLES A. FRY, CLARENCE HARSH, AND RALPH M. SCHORY. U. S. 1,828,462, Oct. 20, 1931. Apparatus for forming rabbeted corners, etc., in ceramic blocks, the apparatus including a cutting member movable from and to a stationary position, block guide means at one side of the cutting member and extending cross-wise thereof, and yielding means normally maintaining the cutting member at the stationary position.

Clay ball disintegrator. LEE O. BATES. U. S. 1,828,589, Oct. 20, 1931. A disintegrator comprising a trough, a disintegrator operable therein, the trough having a top wall open at a portion thereof to form a filling opening, means to supply water into the trough, plate means adjacent the latter means carried by the roof of the trough to avoid undue splashing of the water and ejection of the contents of the trough, the trough having a discharge pipe and a guard plate above the discharge pipe and within the trough.

Tile-shaping and trimming machine. GUSTAF LARSON. U. S. 1,828,869, Oct. 27, 1931. A tile-forming machine comprising a conveyer carrying a plurality of tile-forming blocks undercut on their reverse sides, means to align a series of the blocks, the outer forming faces of the blocks being inclined with respect to the reverse sides, the longitudinal undercut edges of the series of blocks lying in a common plane when the

series is aligned, and stationary knives at opposite sides of the aligned blocks for trimming the longitudinal edges of the tile carried on such blocks.

Feeder for comminuted materials. CLINTON P. HARRIS. U. S. 1,831,561, Nov. 10, 1931. The combination with a hopper for containing comminuted materials and a distributor box into which the materials are to be fed, of a feeder box beneath the hopper, a pair of opposed screw conveyers forcing the materials from the hopper into the feeder box, and a screw conveying the materials from the feeder box into the distributor box.

Volumetric displacement meter. HENRY C. LEESEBERG. U. S. 1,831,671, Nov. 10, 1931. In a volumetric displacement meter, a cylinder of predetermined volume, a piston reciprocable in the cylinder and provided with a piston rod extending exteriorly of the cylinder, means including a ported valve casing and a rotary valve therein for controlling communication between the respective ends of the cylinder and a source of supply of fluid under pressure and a discharge for such fluid, means for imparting rotary movement to the valve including a gear carried by the valve and a rack bar having teeth in mesh with the gear, a latch for holding the rack bar against movement, means carried by and movable with the piston rod for imparting movement to the rack bar and including spring rams having plungers depressible upon contact with the ends of the rack bar to compress their springs, a cam lever coöperating with the latch, means movable with the piston and coöperating with the cam lever for releasing the latch to thereby permit the ram plungers to move the rack bar and through it the valve in timed relation to the reciprocation of the piston, and means for limiting the movement of the rack bar and hence of the valve.

Separating intermixed divided materials. RICHARD PEALE. U. S. 1,832,048, Nov. 17, 1931. (1) A mechanism for separating intermixed divided materials which vary relatively greatly in size but vary relatively little in their specific gravities including, in combination, an air-pervious table, means for feeding to the rear of and maintaining upon the table a bed of materials of substantial thickness, means for gradually moving forwardly and progressively separating the materials of the bed into horizontal strata including devices for forcing an air current through the bed and for longitudinally reciprocating the bed, coöperating devices for concentrating a separated and settled heavier material into a stream, discharging the stream of heavier material from the table, and means for directing a blast of air through the unsupported discharging stream to separate therefrom any residuum of a lighter material. (2) Subjecting a bed of the intermixed materials, supported on an air-pervious support, to the stratifying and separating action of lifting air currents and mechanical vibration, discharging the lighter material as a superior flotant stratum, progressing the settled heavier material transversely beneath the flotant stratum to discharge, impelling the separated heavier material from the support, and subjecting the moving and unsupported heavier material to a lifting air blast to separate therefrom any residuum of a lighter material.

Jigger conveyers. E. RIDGILL. Brit. 357,628, Oct. 7, 1931.

Casting metals, ceramic masses, etc., by the centrifugal process. P. C. FRITZSCHE. Brit. 358,363, Oct. 14, 1931.

Construction of filter presses. M. WILDERMAN. Brit. 358,526, Oct. 21, 1931.

Delivering finely divided or powdered material to conveyers. STEEL BAND CONVEYOR & ENGINEERING CO., LTD., AND W. H. ALLEN. Brit. 358,678, Oct. 21, 1931.

Foundry molding machines of the jarring or jolting type. T. P. MACNAB. Brit. 358,751, Oct. 21, 1931.

Molding machines for foundries and ceramic operations. G. ZIMMERMANN. Brit. 358,781, Oct. 21, 1931.

Producing large-sized ceramic plates. KERAMAG KERAMISCHE WERKE AKT.-GES. Brit. 359,358, Oct. 28, 1931.

Kilns, Furnaces, Fuels, and Combustion

Radiant heat transmission between surfaces separated by nonabsorbing media. H. C. HOTTEL. *Trans. A.S.M.E.*, **53** [14], 265–73 (1931).—Fundamental laws of radiation from solids have been discussed and applied to individual problems of heat transfer in numerous papers. In this one H. indicates just what principles are involved, to how many problems they have been applied, and gives a number of applications of the principles to problems in industrial-furnace design. Fundamental principles and definitions discussed include the definition of normal intensity, Lambert's cosine principle, relation between intensity and emissive power, the square-of-the-distance law, Kirchoff's law, and the Stefan-Boltzmann law. Various surface arrangements are divided into two groups, (1) in which one of the two surfaces is small relative to the distance separating them, and (2) in which both surfaces are of considerable extent relative to their distance apart. Various cases of these and the effect of incomplete absorption are treated mathematically. The task of applying many of the equations given in the paper is simplified by presentation of numerous graphs. See also *Ceram. Abs.*, **9** [9], 767 (1930). E.P.R.

High-temperature insulation. WALDO HUTCHINSON. *Rock Prod.*, **34** [23], 85–87 (1931).—H. discusses the basic idea of insulation and gives graphs showing heat loss from surfaces at various temperatures and air velocities. He states that air space is not an insulator at high temperatures, owing to radiation and conversion in the space. For this reason, brick containing pores or voids large enough to be seen with the naked eye are better heat conductors at high temperatures than brick of the same material with smaller pores or no pores at all. Heat conductivity through walls is discussed and graphs are given showing the relative conductivities of various materials including fireclay brick, red brick, and Sil-O-Cel products at different temperatures. The insulating property of diatomaceous silica is due to its content of as much as 85% of its volume of infinitesimal air cells. Certain calcined grades of it can be used at temperatures as high as 2500°F. Advantages resulting from insulation of furnace installations are saving in fuel, more even temperature distribution, protection of brickwork from rapid temperature changes, and cooler working conditions around the furnace. W.W.M.

Kiln. D. E. GROSSKINSKY. *Klei*, **22** [10], 239–40 (1930); *Chim. & Ind.*, **25** [1], 122 (1931).—G. describes a new kiln with a low consumption of fuel. It is a combination of a chamber kiln with an annular and zigzag kiln. This arrangement combines the advantages of the different kilns. Several kinds of refractory products can be fired simultaneously. M.V.K.

Electric muffle kilns. C. RICHTER. *Sprechsaal*, **64** [43], 787–89 (1931).—The principles for the building of electric muffle kilns are outlined with special references to the problems of heat insulation and economy. Electric kilns are economical only if it is possible to secure a cheap supply of electric energy. W.M.C.

Special kilns used in making blue roofing tile. R. FRANZMEIER. *Tonind.-Ztg.*, **55** [80], 1122–25 (1931).—An old and a modern type of periodic kiln are described which are used in making blue roofing tile. These kilns are built for 3500 to 6000 tile only. Illustrated. W.M.C.

New junior kiln at National Porcelain Co. ANON. *Ceram. Ind.*, **17** [5], 387 (1931).—A Robertson junior-type tunnel kiln has been installed for firing bathroom accessories, small insulators, electrical porcelains, etc. The kiln is 85 ft. long, oil-fired to cone 10 to 11, and has a capacity of 24 trucks per day with a 19-hr. firing schedule. The entrance and exit ends of the kiln are at a temperature of about 150°F. W.W.M.

Round tunnel kiln. ANON. *Ceram. Ind.*, **17** [5], 398–400 (1931).—The W. S.

George Pottery Co., East Palestine, Ohio, has the first commercial installation of a round tunnel kiln for bisque firing of dinnerware. Details of the kiln are given with illustrating photographs. The ware is set on special refractory slabs. Good results have been obtained in firing, with a saving over sagger-type kilns. W.W.M.

Automatic heating unit with two combustion chambers. INDUSTRIAL GAS ENGINEERING CO. *Gas Age-Rec.*, **68** [15], 563 (1931).—Besides providing an accurate automatic temperature control, this new heating unit for application to industrial ovens, driers, kilns, and furnaces offers also an automatic fuel supply and ignition control, together with other safety controls. This heater comprises two concentric cylinders; the outer cylinder is double-walled with insulation between walls and the inner cylinder is lined with refractory and serves as the primary combustion chamber. The fuel (gas or oil) burns partially in this primary combustion chamber and passes through into the large secondary combustion chamber where the combustion is completed. Illustrated. E.J.V.

Combination gas-oil burner. RAY OIL BURNER CO. *Gas Age-Rec.*, **68** [15], 563 (1931).—This combination burner can be changed over from one fuel to the other without loss of time or interruption to the manufacturing process. Operating with either fuel is equally simple, the flame size automatically responding to load requirements. Fuel and air are automatically maintained in the ratio required for proper combustion, at any fire stage, by an interconnected air and fuel linkage. Some operating details are described. Illustrated. E.J.V.

Consumption and costs of fuels for kilns. W. LEDER. *Tonind.-Ztg.*, **55** [78], 1096–99; [79], 1112–14 (1931).—This paper gives a compilation of the costs of fuels used to fire 1000 common brick in different types of kilns. Several tables and graphs show the amount of heat which is necessary in the different firing stages as derived from theoretical calculations and as measured in industrial plants. The influence of different firing methods is outlined and it is shown that it is possible to make economic use of large quantities of waste heat for drying. W.M.C.

Liquefied petroleum gas. O. M. SETRUM. *Jour. West. Soc. Eng.*, **35**, 448–65 (1930); *Inst. C. E. Eng. Abs.; Mech. World*, **90** [2333], 287 (1931).—Natural gas has become an important source of motor spirit and of propane and butane. Eleven per cent of the motor fuel made in the U.S. is derived from natural gas, of which 92% is treated for the extraction of gasoline by compression. The yield of gasoline may attain 15 to 20 gal. per 100 cu. ft. of natural gas. E.P.R.

Natural gas for brick kilns. ANON. *Blast Fur. Steel Plant*, **19** [11], 1492–94 (1931).—Some of the more important advantages of natural gas as a fuel in firing brick kilns are enumerated. The possibility for increased use in this way since long pipe lines have made it more available to plants is pointed out. The type construction desired in kilns for best results is taken up briefly. E.J.V.

Progress in electric firing in the ceramic industry. H. M. WEBBER. *Ceram. Ind.*, **17** [5], 388–92 (1931).—W. states that there are about 45 electric continuous conveyer furnaces in operation firing all sorts of enamelware. Figures are given on the power consumption per unit weight of ware produced. Several types of furnaces are described including a pusher-type copper brazing furnace. This process consists in placing copper wire next to the joints to be brazed and when the melting point of the copper is reached it flows into the seams. Electrically heated annealing leers are also discussed. There are about 150 of these in operation. Their advantages are set forth, including accuracy and uniformity of temperature control, cleanliness, quality of product, and improved working conditions. A standard heating unit used in electric leers is described. W.W.M.

Test values of coal and natural gas in firing sewer pipe. EDWARD F. CLEMENS

AND EUGENE C. CLEMENS. *Brick Clay Rec.*, **79** [9], 400–403 (1931).—The Cannelton Sewer Pipe Co. tested comparative values of coal and natural gas in firing vitrified sewer pipe. Two 30-ft. kilns were used in making the tests, one fired with coal and the other with gas. It was decided to continue firing sewer pipe with coal because the cost of the gas equipment and the upkeep would be higher and a higher type of laborer would be required to operate it. A high thermal efficiency and more uniform firing were obtainable, however, with the gas firing. Illustrated. E.J.V.

Present position of the fuel-oil industries. J. B. C. KERSHAW. *Engineer*, **152**, 146–47 (1931).—The world's natural oil supplies are tabulated and the Maclaurin, Low Temperature Carbonisation Co., Illingworth, and Salermo processes for the production of oil from coal are described. H.H.S.

Properties of gas-air combustion mixtures. W. LITTERSCHEIDT. *Wärme; Gas Age-Rec.*, **68** [15], 548 (1931).—For efficient gas combustion it is essential that the characteristics of gas-air mixtures be determined. A theoretical discussion of ignition velocity and combustion intensity is given. The latter may be expressed by the relation, $J_t = 3600\ [(H_u + Q)/V]\ u(T/293)^2$, in which H_u is the lower calorific value of the gas tested, Q the quantity of heat added, u the ignition velocity, and V the volume of gas burned. E.J.V.

Oil from Queensland coal. ANON. *Queensland Govt. Mining Jour.*, **32** [7], 303–306 (1931).—A ton of coal of ordinary quality will yield 120 gal. of spirit. Internal combustion engines can obtain more energy from 120 gal. of spirit than steam engines can from a ton of coal. The spirit can be made from coal which is too low grade for heating or steam production. E.P.R.

Firing control by use of cones. ANON. *Tonind.-Ztg.*, **55** [86], 1197–98 (1931).—Some general remarks are given as to the best method of using cones for an efficient firing control. W.M.C.

Mechanical stoking of ring kilns. ANON. *Tonind.-Ztg.*, **55** [86], 1200–1201 (1931).—A short review is given. W.M.C.

Water-smoking in an economical way. ANON. *Tonind.-Ztg.*, **55** [84], 1171–72 (1931).—Temperature distribution and the best method of water-smoking used in firing brick in Hoffmann (annular) kilns are discussed. W.M.C.

Regulation of chimney draft. K. WACHWITZ. *Tonind.-Ztg.*, **55** [83], 1163–64 (1931).—A new double valve is described which is said to regulate the draft of a chimney in a satisfactory way, thus resulting in a considerable economy of fuel. W.M.C.

PATENTS

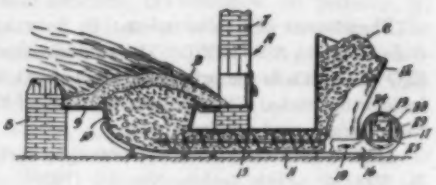
Kiln heating. PHILIP D'HUC DRESSLER. U. S. 1,828,492, Oct. 20, 1931. The combination in a continuous kiln having a kiln chamber with an inlet at one end and an outlet at its opposite end for the insertion and removal of material treated in the kiln chamber and means for moving the material through the kiln chamber from the inlet to the outlet, of a plurality of combustion chambers at the sides of the kiln chamber for supplying heated gases to the latter at points distributed along the length of the kiln chamber between the inlet and outlet, and automatic stokers for feeding solid fuel into the different combustion chambers.

Electric kiln. JOSIAH L. MERRILL. U. S. 1,829,290, Oct. 27, 1931. A kiln of the character described comprising a middle muffle section formed with two independent parallel muffle chambers and two independent end sections connected to the opposite ends of the middle section, each end section having a single combined preheating and cooling chamber communicating with the adjacent ends of both muffle chambers, means supporting the muffle chambers so that their ends are free to expand and contract, and means for causing the ware to travel in opposite directions through the kiln, so that cold

ware traveling in one direction toward a muffle chamber is preheated by radiation from cooling ware leaving the other muffle chamber.

Control of temperature in electric furnaces, etc. ALFRED GLYNNE LOBLEY. U. S. 1,829,416, Oct. 27, 1931. A temperature-control installation for a furnace comprising a thermostat having a high-expansion element, a displacement switch member outside the furnace connected to one end of the element, a low-expansion element connected at one end to the first element within the furnace, and loading spring means associated with the elements tc keep the high-expansion element under tension and the low-expansion element under compression.

Automatic damper. CHARLES A. TJERNBLOM. U. S. 1,830,575, Nov. 3, 1931. A damper comprising a supporting casing through which air is adapted to travel in one direction, an upper damper plate horizontally pivoted in the casing and extending across it, a lower damper plate horizontally pivoted in the casing and extending across it, the pivot of the lower plate being slightly spaced from the upper plate in the direction of travel of the air and the upper plate normally resting by gravity in inclined relation against the upper portion of the lower plate, the lower plate being normally held by gravity in substantially vertical position, whereby as air is forced through the casing, the lower plate will rise for some distance before the upper plate is raised.



Refractory diaphragm for use in surface-combustion apparatus. FREDERICK JOHN COX. U. S. 1,830,826, Nov. 10, 1931. A surface combustion radiophragm comprising two porous strata of granules, one stratum being made of granules of a larger size than the granules of the other stratum, the two strata being integrally joined to make an integral rigid porous structure, the stratum of larger granules forming the back of the radiophragm and the stratum of smaller granules forming the combustion surface thereof, the combustion surface being relatively smooth whereby it is evenly heated and any tendency for the combustion to fire back is prevented.

Stoker. DONALD J. MOSSHART. U. S. 1,830,850, Nov. 10, 1931. In an underfeed stoker, the combination of a retort arranged in a substantially horizontal direction and adapted to receive fuel at one end thereof and discharge the fuel over the sides thereof, a primary feeding mechanism for delivering fuel into the fuel-receiving end of the retort, retort bottom means for supporting the fuel and including a plurality of relatively movable plate-like elements, the movable plate-like elements providing for the feeding of the fuel, the movable plate-like elements being constructed relatively thin and arranged in parallel, overlapping, and stepped relation to one another, and means providing for the movement of the movable plate-like elements in substantially the longitudinal direction of the retort bottom, the means including lost-motion driving connections between adjacent plate-like elements, the lost-motion driving connections comprising abutment members detachably secured to the movable plate-like elements and disposed within slots provided in adjacent plate-like elements.

Kiln brace. CHARLES A. NELSON. U. S. 1,831,316, Nov. 10, 1931. A brace structure for use against the side wall of a kiln in a brickyard, etc., comprising a brace structure proper that is composed of members that have overlapping parts that have sliding engagement for effecting a change in length, one of the members being provided at the free end with a contacting shoe for contacting with the wall, locking means constructed and arranged for checking the members against thrust pressure under holding conditions, the shoe having a plain flat face for being opposed to the wall under con-

tacting conditions, the members being in the form of lengths of pipe of different sizes, the one telescoping within the other, and an annular plug structure being inserted within the larger pipe, the opening therein being such as to provide a sliding fit for the periphery of the smaller pipe.

Brick kilns, etc. C. R. IVORY. Brit. 358,053, Oct. 14, 1931.

Construction of burners for gas-fired ovens or kilns for use in the manufacture of tile, pottery, etc. H. STEELE. Brit. 358,292, Oct. 14, 1931.

Treating ceramic articles, etc., in tunnel kilns or furnaces. HARROP CERAMIC SERVICE CO. Brit. 359,428, Nov. 4, 1931.

Geology

Phenomena of kaolinization. F. SAVELLI. *Chimica*, **6** [5], 162–64 (1930); *Chim. & Ind.*, **24** [4], 882 (1930).—The kaolinization may be produced not only from the loss of K_2O and $4SiO_2$ in the orthoclase Al_2O_3, K_2O, $6SiO_2$, $2H_2O$, but also in a great number of feldspathic rocks. The principal factors of this transformation are atmospheric agents, carbonic gas, and acidity of soil. M.V.K.

Humus formation and destruction by certain higher filamentous fungi in forest soils. R. FALCK. *Forst-Archiv*, No. 16 (1930); *Bied. Zentr.*, **60***A*, 252–53 (1931).—The action of fungi on the lignin and cellulosic matter of beech leaves may result in a "corrosion" process ultimately yielding humus or a destructive process characterized by the production of sugars and organic acids, notably $(CO_2H)_2$. The formation and maintenance of forest humus is examined in the light of these facts. (*B.C.A.*)

Indiana's nonmetallic minerals. WILLIAM N. LOGAN. *Pit & Quarry*, **23** [3], 35–42 (1931).—These include (1) sand and gravel used for structural purposes, (2) sands used in the manufacture of glass, (3) sands used for abrasives, (4) sands used in the manufacture of silica brick, (5) sands, clays, and silts used for foundry purposes, (6) glacial boulders used for structural purposes, (7) sand, quartzites, and cherts used for filtering purposes, (8) limestone used for building purposes, (9) as concrete aggregates, (10) in the manufacture of lime for structural and agricultural purposes, and (11) in the manufacture of natural and Portland cements. E.P.R.

Nonmetallic mineral resources of Iowa. JAMES H. LEES. *Pit & Quarry*, **23** [2], 31–38 (1931).—The list of commercial minerals that are being used is not a long one and is confined to the nonmetallic class. Coal, cement materials, clayware, gypsum and its products, sand and gravel, and limestone and lime make up the list. E.P.R.

Plagioclases of the igneous rocks of the Helle. P. MICHOT. *Ann. soc. géol. Belg.*, **54**, 44–48 (1930).—M. discusses the mutual solubility of orthoclase, albite, and anorthite to explain the absence of separate crystals of orthoclase when its presence is shown by chemical analysis. The zoning of the plagioclases is explained by the effect of irregularly varying pressures on the temperature-composition diagram of the system. R.H.E.

Clays and kaolins. COSIMO ETTORE. *Corriere Ceram.*, **12** [9], 373–77 (1931).—E. gives a mineralogical statement, elementary in character, regarding various types of clays. M.V.K.

Fluorine, its use, and deposits. A. PAVLOWSKI. *Mines, Corrières, Grandes Entreprises*, June, 1930; *Ind. chim.*, **17** [203], 864 (1930).—The glass industry uses fluorine to lower the fusing point of glass and produce the so-called opaline glass, the ceramic industry uses it for manufacturing artistic pastes, the enamel industry, for the production of cooking utensils, and the optic, for subduing ultra-violet rays. Fluorine is found in the form of fluoride of calcium, cryolith, and double sodium and aluminium fluoride. The most important deposits of fluorine of the world are described. M.V.K.

Preparation of fluorspar in the Esterel. V. CHARRIN. *Céram. Verrerie*, No. 826, pp. 191–92 (1931).—A fluorspar content of 90 to 95% is required for the ceramic and chemical industries and it is necessary to enrich the ore. The deposits consist of dikes, some of which are only a few centimeters in width and others 8 meters. The fluorspar is pure in the small dikes but in the large dikes may run below 80%, the principal impurities being barite and silica. The machinery resembles that used for concentrating ores and consists of trommels, conveyers for hand picking, crushers, vibrating classifiers, and filtering basins. The material is crushed to pass a 5-mm. mesh and very finest material is separated in a water classifier. T.N.McV.

Bauxite in France. Σ. V. CHARRIN. *Ind. chim.*, **18** [205], 85–89 (1931).—C. gives the definition of what bauxite is and discusses (1) its physical and chemical character: (*a*) color, (*b*) texture, (*c*) density and hardness, (*d*) fusibility, (*e*) porosity, (*f*) composition; and (2) its classification and use: white, red, and gray bauxites. The deposits of bauxite in France are described. About 300,000 tons of bauxite are produced, of which 50% is used by the aluminum industry, 15% by the chemical, 10% by the cement, 10% by the refractory, 5% by the abrasive, and 5% by other different industries. M.V.K.

Mining and manufacture of china clay in England. T. HEDLEY BARRY. *Paint & Varnish Production Manager*, **5** [1], 24–29 (1931); *Sprechsaal*, **64** [23], 433 (1931).—The English kaolin deposits at St. Austell in Cornwall and Dartmour in Devon are described. Characteristics of the clay, method of treating, and its uses are discussed. M.V.K.

Cornish china clay. E. H. DAVIDSON. *Eng. Mining Jour.*, **132** [6], 264 (1931).—The clay was formed by the weathering of granite by magmatic water. It is mined by hydraulic methods, the sand and mica being removed by sedimentation in concrete pits, and the water by evaporation in drying pans. C.R.A.

Cobalt discovery in Westphalia. QUIRING. *Times Eng. Supp.*, **28**, 537 (1931).—The accidental discovery of the old Philipps-Hoffnung mine enables Germany not only to supply her own needs but to export considerable quantities of cobalt. H.H.S.

Pneumatolytic synthesis of silicates. I. C. J. VAN NIEUWENBURG AND H. B. BLUMENDAL. *Rec. trav. chim.*, **4** [12], 129 (1931); *Sprechsaal*, **64** [26], 488 (1931); for abstract see *Ceram. Abs.*, **10** [8], 597 (1931). M.V.K.

Differences in sands. HAROLD ORVILLE WHITNALL. *Rocks & Minerals; Rock Prod.*, **34** [22], 44–46 (1931).—Formation and characteristics of different types of sand are described and illustrated by photographs. W.W.M.

BOOK AND BULLETINS

World Minerals and World Politics. C. K. LEITH. xii + 213 pp. Price $2.00. Reviewed in *Bull. Imp. Inst.*, **29**, 263 (1931); for abstract see *Ceram. Abs.*, **10** [7], 531 (1931). H.H.S.

Utilization of dolomite and high-magnesium limestone. PAUL HATMAKER. Bur. Mines, *Information Circ.*, No. 6524. 18 pp. This paper covers briefly the particular field of dolomite and magnesium limestone and certain uses of high-calcium limestone are mentioned to show more clearly the limitations of the magnesia rocks. A brief description of the material, composition, and properties is given. The uses which, to a varying degree, are dependent upon or affected by the chemical composition of the stone are listed as follows with a brief description of the effect of the composition in the several uses: (1) refractories, (2) technical carbonate, (3) certain processes of paper manufacture, (4) some types of lime mortars, (5) blast-furnace flux, (6) Vienna lime, (7) glassworks, (8) carbon dioxide and chemicals, (9) agriculture, (10) paints, kalsomine, etc., (11) ceramics, (12) prepared whiting, (13) rubber preparations, (14) tanneries,

(15) fungicides, and (16) such miscellaneous uses as in pig-iron casting, in "pickling" iron and steel, in wire drawing, and in the manufacture of strawboard. The report also discusses production, occurrence, prices, imports, and exports. A bibliography is included. R.A.H.

Study of the properties of Texas polyhalite pertaining to the extraction of potash. I. H. H. STORCH AND LOYAL CLARKE. Bur. Mines, *Rept. of Invest.*, No. 3002. 19 pp. (Free.) The discovery of large deposits of polyhalite ($K_2SO_4 \cdot MgSO_4 \cdot 2CaSO_4 \cdot 2H_2O$) in Texas led to an investigation of possible industrial processes for the extraction of potash from this material. The report discusses the mechanism of the extraction of calcined polyhalite with boiling water and outlines two possible industrial processes for the production from this material of (1) potassium sulphate and (2) potassium sulphate and magnesium sulphate. **II. Rate of decomposition of polyhalite by water and by saturated sodium chloride solutions.** H. H. STORCH. *Ibid.*, No. 3032. 11 pp. The report describes the results obtained by a study of the rate of decomposition of this mineral by water and saturated salt solutions. **III. Calcination of polyhalite in a rotary kiln of laboratory size.** LOYAL CLARKE, J. M. DAVIDSON, AND H. H. STORCH. *Ibid.*, No. 3061. 12 pp. (Free.) Construction and operation of a rotary kiln are described and results are given of the study of the variables and factors affecting extraction experiments on 10- to 100-mesh Polish polyhalite and on such polyhalite of other degrees of fineness. **IV. Experiments on the production of potassium chloride by evaporation of leach liquors from decomposition of uncalcined polyhalite by boiling saturated sodium chloride solutions.** H. H. STORCH AND F. FRASS. *Ibid.*, No. 3062. 7 pp.; *Rock Prod.*, **34** [16], 49 (1931).—Ninety per cent of the water of the leach liquors interspersed with 3 crystallization steps will yield 78% of the potash as crude KCl which may be readily refined to produce pure KCl. The possibility of industrially workable deposits of sylvanite in Tex. and N. M. is mentioned. **V. Suggested processes for the production of syngenite and by-product magnesia.** H. H. STORCH AND N. FRAGEN. *Ibid.*, No. 3116. 19 pp. Commercially feasible processes producing potassium sulphate or syngenite or both are suggested and flow diagrams are given. Precipitation of magnesium ammonium carbonate followed by thermal decomposition may be of value in developing a process having magnesium oxide as a by-product. R.A.H.

Boron and its compounds. R. M. SANTMYERS. Bur. Mines, *Information Circ.*, No. 6499. 37 pp. (Free.) This report describes and notes the occurrence of boron minerals and gives a detailed history of the production, distribution, and consumption of borax, boric acid, and boron. Borax is widely used in enamels because of its fluxing action as well as its low fusibility. Its value in glass manufacture is due to properties which (1) impart high refractiveness, (2) reduce tendency to devitrification, and (3) cause lowering of thermal expansion. R.A.H.

Umber, sienna, and other brown-earth pigments. R. M. SANTMYERS. Bur. Mines, *Information Circ.*, No. 6504. 14 pp. (Free.) This report discusses properties, uses, and substitutes, and gives data on sources, preparation, production, imports and exports, marketing, and the industry in foreign countries. R.A.H.

The kaolin minerals. C. S. ROSS AND P. F. KERR. U. S. Geological Survey, *Paper*, No. 165-*E*. 29 pp. Price 15¢. For abstract see *Ceram. Abs.*, **9** [5], 375 (1930). R.A.H.

Geophysical Abstracts. XXIX. F. W. LEE. Bur. Mines, *Information Circ.*, No. 6559. 25 pp. This report lists and describes original German patents concerning gravimetric and magnetic methods of geophysical prospecting. For Part XXVIII see *Ceram. Abs.*, **10** [12], 860 (1931). R.A.H.

Chemistry and Physics

Separation and determination of boric acid and alumina. Use for silico-aluminous products (glass and enamels). MALAPRADE AND SCHNOUTKA. *Compt. rend.*, **192**, 1653 (1931); *Sprechsaal*, **64** [39], 720–21 (1931).—The classical determination of boric acid by neutralizing the strong acids present with strong bases and methyl orange as indicator and the subsequent neutralizing of boric acid by the same base in the presence of a sufficient quantity of mannite or glycerin and phenolphthalein as indicator, according to the equation $HBO_2 + NaOH = NaBO_2 + H_2O$, is not possible in the presence of aluminium salts. The change of color of methyl orange is not apparent and between this change of color and that of phenolphthalein, a certain quantity of the base is used in the precipitation of $Al(CH)_3$ by the base, according to the equation $Al^{+++} + 3OH^- = Al(OH)_3$. Alumina must therefore be precipitated before determining B_2O_3. The methods based on the volatility of boric acid ester are troublesome. If a NaOH solution containing sodium aluminate is saturated cold with sulphuric acid and the solution boiled, the surplus sulphurous acid is again separated and the alumina separates quantitatively in the weak acid solution as a white basic sulphite of an undefined composition. This sediment is thick and can be easily filtrated and washed; any boric acid present goes into the filtrate. It can be determined there when the solution is slightly acidified with HCl and boiled for about 20 min. till H_2SO_4 and CO_2 are completely expelled; care must be taken that the solution is not too concentrated. The quantities of boric acid which evaporate with steam are small and can be disregarded. The following determination of boric acid is made in the usual way. The aluminium separated as basic sulphite is dissolved in HCl and precipitated with NH_4OH. Glasses and enamels are decomposed with K_2CO_3, the fusion dissolved with a little water, and filtered off from the insoluble oxides and the small amount of silico-aluminate formed. The filtrate is saturated with H_2SO_4 and treated as above. The complete precipitation of SiO_2 is not required as it does not affect the titration of boric acid. M.V.K.

Hydrosol of silicic acid. I. Hydrosol prepared from ethyl silicate by hydrolysis. K. INABA. *Sci. Papers Inst. Phys. Chem. Research* [Tokio], **15**, 1 (1930); *Sprechsaal*, **64** [26], 487 (1931).—Contradicting data are found in literature on the properties of the hydrosol of silicic acid in its manner of preparation, raw products, and conditions of the formation of the sol. The preparation of silicic acid sol by hydrolyzing ethyl silicate is described. **II. Electrical properties of the hydrosol of silicic acid.** *Sci. Papers Inst. Phys. Chem. Research* [Tokio], **15**, 16 (1930); *Sprechsaal*, **64** [26], 487 (1931).—The migration velocity of the following four sols was determined: (1) "neutral sol" of ethyl-silicate with an alkali as peptizing agent, (2) "acid sol" of ethyl silicate with an acid as peptizing agent, (3) a sol obtained by hydrolysis of silicon tetrachloride (this sol was stable only in the presence of acids and coagulated when the acid was removed by dialysis), and (4) a sol of sodium silicate and hydrochloric acid which was stable in the neutral state. **III. Stability of the hydrosol and the influence of electrolyte on it.** *Sci. Papers Inst. Phys. Chem. Research* [Tokio], **15**, 277–87 (1931); *Sprechsaal*, **64** [31], 577 (1931).—Changes in stability of dilute alkaline solutions of silica in the presence of salts were investigated by measuring viscosity and conductivity. M.V.K.

Unfritted glazes for pottery containing calcium borate. K. ZIMMERMAN. *Klei*, **22** [23], 271–79 (1930); *Chim. & Ind.*, **25** [5], 1175 (1931).—Unfritted glazes from natural borates have been difficult to obtain owing to their impurities. Tests were made with borates of a synthetic calcium, CaO, B_2O_3, 2 aq., offering numerous advantages as the elimination of fritting, cheapness, and production of glazes with a specific gravity less than those with lead. This glaze, however, had a tendency to produce fissures. To avoid this the proportion of ingredients was changed and kaolin was replaced by

fat clays of the ball-clay type. These glazes also showed a white milky reflection with a certain thickness of the layer. Z. found that the following proportions eliminate this factor: 60 parts calcium borate, 25 parts feldspar, 15 parts kaolin, 20 parts ball clay, and 2.4 parts dextrine. The glaze contains 8.89 CaO, 0.11 K_2O, 0.105 Al_2O_3, 1.323 SiO_2, and 0.89 B_2O_3. M.V.K.

New method for colorimetric determination of manganese. R. G. HARRY. *Chem. & Ind.*, **50** [39], 796 (1931).—The method is based on the reaction of tetramethyldiaminodiphenylmethane with manganese hydroxide in acetic acid to produce a deep blue color. Directions for preparing the required solutions and for making the test are given in detail. G.R.S.

Rapid method for determining the quantity of silica in alunites. A. D. DYMOV. *Chim. & Ind.*, **24** [4], 812 (1930); for abstract see *Ceram. Abs.*, **10** [11], 807 (1931). M.V.K.

Colorimetric determination of SiO_2, especially in water. OTTO LIEBKNECHT, LOTHAR GERB, AND ERICH BAUER. *Z. angew. Chem.*, **44** [42], 860–63 (1931).—A colorimetric method for the determination of small amounts of silica is based on the fact that the addition of ammonium molybdate solution to an acidified solution of silica causes a yellow color by the formation of a silicomolybdanic acid. Fe''' and P interfere with the determination. L.T.B.

Obtaining potash salts from insoluble minerals. G. CALGANI. *Ann. chim. applicata*, **20** [11], 522–27 (1930); *Chim. & Ind.*, **25** [3], 630 (1931).—About 75 to 80% potash was dissolved from leucite by cold nitric acid; the feldspars were but slightly affected. Aluminum is converted into a nitrate and by decomposing with heat, pure alumina is obtained. The residue is composed of very porous silica with considerable absorbing power. M.V.K.

Hydroxyquinoline method for analysis of cement. ANON. *Tonind.-Ztg.*, **55** [74], 1042–43 (1931).—A review is given of the methods developed by different authors to analyze cement using hydroxyquinoline. The main advantage of using this chemical is the comparatively short time necessary for the analyses. W.M.C.

Determining fluorine. P. MONGNAND. *Compt. rend.*, **192**, 1733 (1931); *Sprechsaal*, **64** [39], 720 (1931).—The methods of Rose and of Carrière and Romanet (see *Ceram. Abs.*, **10** [7], 525 (1931)) are criticized. Rose separates CaF_2 in an acetic solution, while in the other method, CaF_2 is separated with an ammoniacal solution. M.V.K.

Criticism of classical methods of analysis of silicic aluminous calcareous alkali compounds. J. DEFORGE. *Chim. & Ind.*, **26** [3], 636 (1931); for abstract see *Ceram. Abs.*, **10** [9], 665 (1931). M.V.K.

Determination of the aluminum oxide content in alumino-borosilicates. O. W. KRASSNOWSKY. *Sprechsaal*, **64** [39], 720 (1931); for abstract see *Ceram. Abs.*, **9** [5], 386 (1930). M.V.K.

Systematic qualitative analysis by modern drop reactions. C. J. VAN NIEUWENBURG. *Mikrochemie*, **9**, 199 (1931); *Analyst*, **56**, 483–85 (1931).—The scheme, as worked out at Delft University, Holland, combines some of the older group separations with modern "spot" tests for identification of both metals and radicals. H.H.S.

Determining the heat of formation of silicates from corresponding oxides. R. NACKEN. *Chim. & Ind.*, **24** [6], 1397 (1930); for abstract see *Ceram. Abs.*, **10** [2], 146 (1931). M.V.K.

Melting point diagrams of highly refractory oxides. H. VON WARTENBERG AND W. GURR. *Z. anorg. allgem. Chem.*, **196** [4], 374–83 (1931).—The following systems were studied: *Fe_2O_3–ZrO_2*. Fe_2O_3 exists up to temperatures of 1400°C, above which it decomposes to Fe_3O_4 and O_2. The ferric oxide volatilizes rapidly from the mix above 1800°. It forms a eutectic with ZrO_2 which melts at 1520°. *Mn_3O_4–ZrO_2*. There exists

a eutectic which melts at 1620°. Mn_3O_4 is readily volatile from the mix. *ZnO–ZrO_2*. The eutectic melts at 1810°, but the ZnO is vaporized rapidly. *CeO_2–ZrO_2*. CeO_2 melts at 2600°, is appreciably volatile at 2400°, and decomposes at 2300°. The eutectic with ZrO_2 melts at 2400°. *NiO–ZrO_2*. The eutectic in this system melts at 2050°. *CoO–ZrO_2*. The eutectic melts at 1850°. *TiO_2–ZrO_2*. TiO_2 dissociates at 1800°. The partly dissociated form melts at 1850° and forms a eutectic with ZrO_2 which melts at 1750°. *SnO_2–ZrO_2*. SnO_2 volatilizes too rapidly to make any determinations. *SiO_2–ZrO_2*. SiO_2 volatilizes gradually, even from the compound $ZrSiO_4$ above 1800°. Melting diagrams of all of these systems are given. See also abstract by Wartenberg and Werth, *Ceram. Abs.*, **9** [11], 941 (1930). L.T.B.

Calculating average particle size from screen analysis. F. C. Bond. *Eng. Mining Jour.*, **132** [1], 15 (1931).—Bond discusses a method of calculating average particle size for any screen fraction and methods of extrapolating to determine average size of particles passing the finest screen. C.R.A.

Volume changes due to weathering of ceramic ware. Anon. *Ceram. Ind.*, **17** [3], 206 (1931); for abstract see *Ceram. Abs.*, **10** [1], 67 (1931). W.W.M.

Thermal dissociation of pyrite. Louis d'Or. *Jour. chim. phys.*, **28** [7], 377–408 (1931).—Researches on the thermal dissociation of pyrite are described. See also *Ceram. Abs.*, **10** [1], 71 (1931). M.V.K.

Why crystals exist. F. Zwicky. *Proc. Nat. Acad. Sci.*, **17** [9], 524–32 (1931).—The following scheme was proposed in order to understand the relation between structure-sensitive and structure-insensitive properties of the crystalline state: (1) The ordinary cohesive forces whose action radii are of the order of atomic dimensions are responsible for the condensed states of matter, but are not characteristic for the crystalline state. (2) Transition from the liquid to the crystal can only be effected by the simultaneous coöperation of a great number of atoms in regard to a definite directional arrangement. (3) Several directional phenomena which depend on the coöperation of many particles are briefly described. (4) The coöperative phenomenon which is responsible for the stability of a certain crystal will not, in general, have the same symmetry character as the primary structure. It follows that the crystal as a whole cannot be represented by an ideal crystallographic lattice. A secondary structure must be introduced. The peculiar coexistence of perfection and imperfection which is found in most crystals can easily be derived. G.R.S.

Migration studies with ferric oxide sols. II. Negative sols. F. Hazel and G. H. Ayres. *Jour. Phys. Chem.*, **35** [11], 3148–59 (1931).—The conversion of positive ferric oxide sols to negative sols by means of potassium ferrocyanide is shown in relation to the hydrogen ion concentration of the system. The isoelectric point of this sol has been shown fo be uniquely determined by the hydrogen ion concentration of the system. The effect of cations on the migration velocity of negative sols is illustrated. For Part I see *Ceram. Abs.*, **10** [12], 864 (1931). G.R.S.

Oxide hydrates and active oxides. Relation between the history of ZnO and its catalytic activity for methane decomposition. G. F. Hüttig, Oskar Kostelitz, and Istvàn Fehèr. *Z. anorg. allgem. Chem.*, **198** [1], 206–18 (1931).—A series of ZnO preparations was made by a systematic variation of the conditions under which they were formed. All experiments were conducted at 300°C and one atmospheric pressure. It is impossible to detect any effect of particle size on the catalytic activity. ZnO is put into three groups according to the methods of preparation: (1) ZnO made by the thermal decomposition of Zn compounds, *e.g.*, $ZnCO_3$, which all show high reactivity. This is due to the fact that ZnO does not form a stable crystalline form immediately after the decomposition. It is the first state (unstable) in which the ZnO occurs which is the important one from a catalytic standpoint. (2) ZnO made by the decomposition

of amorphous zinc compounds (dehydration of precipitates): These may be grouped according to their aging characteristics beginning with the unordered aggregate and ending with the undispersed particles in the stable crystalline form. (3) ZnO made by direct combination: Zn + O = ZnO. The zinc oxides with the greatest general catalytic action belong to the two last groups. L.T.B.

Data. II. T. W. GARVE. *Clay-Worker*, **96** [4], 226–27 (1931).—Definitions of centrifugal force, the various types of specific gravity, and a table of specific gravities of solids are presented in this installment. For Part I see *Ceram. Abs.*, **10** [12], 868 (1931). E.J.V.

Structures of some silicates. J. W. GRUNER. *Amer. Mineralogist*, **16** [10], 437–54 (1931).—The structures of the silicates which have been completely investigated are reviewed. Eight types of structures exemplified by more than 30 single silicates or groups of silicates are discussed. A few observations in regard to the development of cleavage and to endless double chains of alternating SiO_4 and AlO_4 groups are included. Structural diagrams for each group and certain members of these groups are shown. The purpose of these diagrams is to indicate how the ions are grouped and which of them are linked together. The diagrams are to take the place of complicated projections not easily understood by mineralogists who have had no opportunity to study actual models of the structures. G.R.S.

Mass spectra of glasses, salts, and metals including the construction of a circular mass spectrograph. H. MURAWKIN. *Ann. Physik*, **8** [3], 353–84; [4], 385–432 (1931).—A new circular mass spectrograph of high dispersion was developed. Spectra of different glasses within the range 900 to 1600°K were taken as well as of alundum cement. A strong emission of Na, K, Mg, and Ca was found and a considerable emission of Si and O, whereas heavy metals were found irregularly and not often. The oxygen isotope ions, O^{18}, O^{18++}, O_2^{16-18}, and O_2^{18}, were found for the first time; besides these, Na_2, Mg_2, K_2, Si_2, Li^{++} Mg^{++}, Ca^{++}, and isotopes of K and Ca were also found. The mechanism of emission is believed to be electrolytic action and ionization by impact. The strongest positive radiator found was Jena glass. Mass spectra of different salts and metals (W, Pt, Cu, etc.) were also investigated. W.M.C.

Nondestructive testing by gamma rays from radium. R. F. MEHL. *Mech. World*, **90** [2334], 310–12; [2335], 325–28 (1931).—The interest in the gamma ray lies chiefly in its much shorter wave length. It was apparent from the beginning that if satisfactory radiographs could be taken with gamma rays a number of real advantages would accrue: the shorter wave length would permit taking pictures through thicknesses of steel far beyond that possible with X-rays and the source of radiation (radium held in a very small capsule) would be entirely portable, making it possible to radiograph structures in almost any conceivable position. In general, the work on radiography by gamma rays is successful. The present article attempts to bring to readers the results obtained, the necessary technique, and the general features characterizing the method. To obtain a comparison between the X-ray and the gamma ray from the exposure-time standpoint, consider the ratios in time between that necessary to prepare a photograph through 6 in. of steel and that through 3 in. of steel first with X-rays and then with gamma rays. Reading from the exposure curve for X-rays, this ratio is $\left(\frac{t_6''}{t_3''}\right)$ X-rays = 5000. In the lack of an exposure curve for gamma rays this ratio may be calculated theoretically from the absorption coefficients, for the ratio should stand in direct proportion to these coefficients. Such a calculation indicates a ratio $\left(\frac{t_6''}{t_3''}\right)$ gamma rays = 45, which can, and has been, confirmed experimentally. These ratios show that the increased time to

obtain a radiograph through additional thickness for gamma rays is much less than that for X-rays. E.P.R.

Application of X-ray crystal analysis to industrial problems. ANON. *Refrac. Jour.*, **7** [10], 462 (1931).—The department of Scientific and Industrial Research has recently published a report on "The Application of X-Ray Crystal Analysis to Industrial Problems." E.P.R.

Swelling and shrinkage of clays and kaolins. L. A. SHMELEV. *Ceramics & Glass*, **7** [6], 35–36 (1931).—S. discusses the interdependence of swelling and shrinkage of clays and kaolins. Formulas and equations are given which can be used both for clay and ceramic mixtures. See also *Ceram. Abs.*, **10** [12], 867 (1931). M.V.K.

Sedimentation of clay suspensions. A. BOUTARIC AND M. ROY. *Compt. rend.*, **190**, 272 (1930).—Velocity of sedimentation is proportional to the viscosity of the suspension calculated according to Einstein's formula: $n = n_o\ (1 + 2.5\ \phi)$, n and n_o are viscosities and ϕ is the ratio of the volume of the particles to the total volume of the suspension.

Initial velocity of sedimentation is $V = \frac{l}{\alpha + \beta c}$ where c is the concentration. Velocity of sedimentation at any moment is $\frac{dx}{dt} = \frac{A}{l + \frac{Bc}{l - x}}$, l is the initial height, x is the amount of fall at any moment, and c is the concentration. Tensio-active substances such as camphor, menthol, and isoamyl alcohol were found to have no effect on the sedimentation. Measurements were made in a tube 100 cm. long and 1.8 cm.^{2} with a cross-section containing 10 g. kaolin and 150 cc. of acidulated water. R.H.E.

Study of the progressive drying up of solutions. PAUL BARY. *Jour. chim. phys.*, **28** [1], 1–13 (1931).—By this method B. determined some characteristics of solutions not heretofore observed, in particular, the existence of two kinds of colloidal dispersions and of an infinite variety of intermediate types. Simple colloidal solutions are differentiated from suspensions by (1) their capability of producing jellies, *e.g.*, transparent elastic masses which change into vitreous solids when drying up is complete; and (2) absence of the Tyndall effect and the impossibility of detecting granules in them by the ultramicroscope. M.V.K.

Spinels. III. Cobalt and zinc titanates. L. PASSERINI. *Gazz. chim. ital.*, **60** [12], 957–62 (1930).—Co_2TiO_4 and Zn_2TiO_4 were prepared by heating to 900° titanic acid with cobalt and zinc nitrates, respectively, in the necessary quantities. The compounds obtained were examined by X-rays by the powder method. The calculation of the factor of structure showed that both compounds crystallize in the cubic system with a lattice structure of spinel type (8*f*, 16*c*, 32*b*; spatial group O_h^7). For Co_2TiO_4, $a = 8.42 \pm 0.005$ A.U., volume, $v = 596.94 \times 10^{-24}$ cc., calculated density = 5.12. For Zn_2TiO_4, $a = 8.410 \pm 0.005$ A.U., $v = 594.82 \times 10^{-24}$ cc., $d = 5.43$. For Parts I and II see *Ceram. Abs.*, **8** [12], 920 (1929). M.V.K.

Iron titanates. B. PESCE. *Gazz. chim. ital.*, **61** [2], 107–11 (1931).—Ilmenite ($FeTiO_3$) was artificially prepared from TiO_2 and FeC_2O_4. Both the ferrous and ferric orthosilicates were obtained. The chemical characteristics of these compounds were ascertained by Röntgenographic analysis. M.V.K.

Studies on the calcium aluminates. I. Crystallization of calcium solutions at 20°C. GUNNAR ASSARSSON. *Z. anorg. allgem. Chem.*, **200** [4], 385–408 (1931).—The aluminate compounds are found in cement clinker. Many studies have been made on the hydration of these compounds but this article is limited to the action of lime water on four pure anhydrous calcium aluminates and on the pure gel of aluminum hydroxide, and to the study of the products which separate from mixtures of limewater and calcium

aluminate solutions at 20°C. The preparations were studied microscopically. Solubilities of the pure calcium aluminate hydrates were determined. Staining tests by the method of Keisermann and microanalyses of the residues and precipitates were made. Complete data are given for the following compounds: $CaO \cdot H_2O$, $4CaO \cdot Al_2O_3 \cdot 13.5H_2O$, $3CaO \cdot Al_2O_3 \cdot 12.5?H_2O$, $3CaO \cdot Al_2O_3 \cdot 6H_2O$, $2CaO \cdot Al_2O_3 \cdot 8?H_2O$, $Al_2O_3 \cdot nH_2O$ (n = 3–4). A small portion of the ternary diagram, Al_2O_3–CaO–H_2O, is reproduced showing the regions of crystallization of these compounds. The fields are not sharply defined but overlap due to the formation of metastable solutions. A full discussion is given of the portion of the diagram which the author completed. L.T.B.

Reactions in the solid state at high temperatures. Determination of the rate of reaction in decompositions which are characterized by an evolution of gas. WILHELM JANDER AND ERNA HOFFMANN. *Z. anorg. allgem. Chem.*, **200** [3], 245–56 (1931).—The rate of reaction was measured by determining the volume of gas at constant pressure. Studies were made on the systems $BaCO_3 + SiO_2$ and $BaCO_3 + Nb_2O_5$. Reaction in the solid state is independent of the pressure. L.T.B.

Static rigidity of plastic clays. CHARLES TERZAGHI. *Jour. Rheol.*, **2** [3], 253–62 (1931).—Two identical clays with identical water contents may have different "static resistance" depending on the history of the samples. Since the capillary tube method involves experimenting with thoroughly kneaded samples, the values obtained by means of this method have no validity for clays in the natural state. When a sample of plastic clay is submitted to a stress with increasing intensity, the plastic flow is preceded by a gliding flow which seems to have its seat in the highly viscous water surrounding the points of actual adhesion. The stress at which this "gliding flow" starts is considerably smaller than the "static resistance." It is believed that the "static resistance" represents the sum of the adhesion between the solid particles and both the solid and highly viscous films of water. The threshold value at which the gliding flow starts is called the "bond resistance." The term "static rigidity" is misleading because it involves the conception that no flow takes place under stresses which are smaller. It is proposed to call it "shearing resistance." The plastic flow consists in alternately breaking and reëstablishing the bond between the particles, whereby the particles change their partners. The force available for performing this work is equal to the difference between the total stress and the shearing resistance. The excess force required for maintaining the flow increases in simple proportion with the number of "contacts" per unit of time which in turn increase in simple proportion with the speed of the flow. G.R.S.

Depth and rigidity of sediment in flocculated clay suspensions. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. *Trans. Faraday Soc.*, **27** [10], 629–32 (1931).—When a suspension of hydrogen clay which has been flocculated by the addition of a small quantity of an electrolyte is left overnight, the volume of the sediment after an arbitrary time (16 hr.) is reproducible within narrow limits. When shaken and left for a second period of 16 hr. the sediment volume is usually about 2% less and further repetitions cause similar progressive reductions. Substitution of Ca^{++} or Ba^{++} for some of exchangeable H does not change the sediment volume. Addition of $CaCl_2$ and $BaCl_2$, respectively, to these suspensions of substituted clays does not appreciably change the sediment volume up to a normality of chloride of about $N = 1$. When the clay contains exchangeable Na^+ or K^+, high concentrations of the corresponding chlorides are required to flocculate the clay. In these cases and whenever the clay is suspended in a chloride of about normal strength or over, a thixotropic gel of larger volume is formed. The strength of the rigid structure of the sediment depends on the exchangeable ions present and on the nature and concentration of the added salt. The relationships involved appear to be complex. The

reproducibility of the sediment volume obtained in dilute salt solutions suggests that a measurement of this quantity may be of use in soil studies. G.R.S.

Physical properties of the soil under different conditions of cultivation. NICOLAS KURTIAKOV. *Ann. sci. agron.*, **46**, 461–74 (1929).—The physical properties (absolute weight, porosity, aeration, and water-holding capacity) of the soil under spring barley, winter wheat, lucerne, and April fallow were determined biweekly during June and July. The best conditions were found in the April-fallowed soil which showed minimum absolute weight and maximum porosity, aeration, and water-holding capacity. Under lucerne were found the greatest absolute weight and least porosity. The soil under spring barley and winter wheat had intermediate physical properties. A negative correlation ($r = -0.92 \pm 0.04$) was noted between the absolute weight and the porosity. The coefficient of correlation for the porosity and water-holding capacity was found to be $r = +0.59 \pm 0.15$; since a positive correlation is evidenced here, any process which increases the porosity will produce a certain increase in the water-holding capacity. See following abstract. (*C.A.*)

Physical properties of disperse systems and of colloids of soil. NICOLAS KURTIAKOV. *Ann. agron.*, **1**, 346–51 (1931).—Increase in the surface of dispersed quartz particles and hygroscopicity were found to be correlated. Two samples of subsoil loess showed a similar relationship. In a chernozem soil the fraction < 0.001 mm. diameter and the power of imbibition diminished with depth. This influence of size of particle on power of imbibition is very clear with quartz particles. Viscosity changes are due to the presence of suspensoids and this depends on the degree of dispersion. Viscosity of a soil suspension as a means of determining the size of the soil surface is important. Experiments on kaolin dispersions showed that (1) their viscosities were greater than distilled H_2O and (2) as the particles fell to the bottom the viscosity approached that of distilled H_2O. The laws of dispersion, in their general sense at least, should be applied to soils. (*C.A.*)

BOOKS

Physics of Solids and Fluids with Recent Developments. P. P. EWALD, TH. POSCHL, AND L. PRANDTL. Trans. into English by J. Dougall and W. M. Deans. Blackie and Son, Ltd., London and Glasgow, 1930. Reviewed in *Jour. Rheol.*, **2** [3], 318 (1931).—The book consists of a series of six articles reprinted from the 11th edition of Müller-Pouillets' Lehrbuch der Physik. The chapter headings are as follows: (1) elasticity and strength of materials, (2) friction of solid bodies, (3) the mechanical structure of solids from the atomic standpoint, (4) equilibrium of liquids and gases, (5 and 6) the flow of liquids and gases. G.R.S.

Physics of High Pressure. P. W. BRIDGMAN. The Macmillan Co., New York. 398 pp., illustrated. Reviewed in *Mining & Met.*, **12** [299], 13 (1931).—This consists of a summary of work that has been done on the phenomena of materials under high pressures. It should make it easier for other workers to apply this work to their own problems, *e.g.*, the geologists who have formed their theories of earth flexure and fracture on a slender basis of physical knowledge. E.J.V.

Industrial Electrochemistry. C. L. MANTELL. McGraw-Hill Book Co., Inc., New York. Price $5.00. Reviewed in *Can. Chem. Met.*, **15** [10], 50 (1931).—This volume is presented as an industrial text book on electrochemistry, too frequently relegated to the position of a subdivision of physical chemistry and inadequately treated from the engineering standpoint. The title is intended to be broadly inclusive of the theoretical and technical sides of electrochemistry, the aqueous and fused electrolyte industries, electrothermics, and the electrochemistry of gases, as well as the distinctly engineering aspects. E.J.V.

What Is Matter? (Was ist Materie?) WILLIAM BRAGG. Akademische Verlagsgesellschaft, Leipzig. 190 pp., 57 illustrations. Reviewed in *Chim. & Ind.*, **26** [2], 501 (1931).—This book contains 6 reports dealing with the atom (properties of matter and atomic models), the structure of gases and liquids, and a discussion of crystals, diamonds, ice and snow, and metals. The character of the book is experimental without mathematical developments. M.V.K.

Elutriation Analysis. H. GESSNER. Reviewed in *Chim. & Ind.*, **25** [4], 1043 (1931); for abstract see *Ceram. Abs.*, **10** [10], 736 (1931). M.V.K.

Spectrum Analysis in Mineralogy. A. A. FITCH. Reviewed in *Amer. Mineralogist*, **16** [10], 472 (1931); see also *Ceram. Abs.*, **10** [11], 805 (1931). G.R.S.

Handbook of Chemical Microscopy. Vols. I and II. E. M. CHAMOT AND C. W. MASON. Reviewed in *Jour. Phys. Chem.*, **35** [11], 3424 (1931); for abstract see *Ceram. Abs.*, **10** [8], 608 (1931). G.R.S.

Book Review

Glazes, Enamels, Ceramic Colors, and Masses. E. I. ORLOV. State Scientifico-Technical Publication, Leningrad, 1931. 2d ed. 314 pp. 4 rubles 50 copek. The first part of this book deals with (1) raw materials used in preparing glazes and enamels; (2) Seger cones; (3) coefficients of expansion; (4) examples of glazes; (5) properties of glazes and their adjustment to the body: (*a*) influence of the chemical composition on the properties of bodies and glazes, (*b*) physical investigations of glazes, (*c*) relation of glazes to the body, and (*d*) colored glazes; (6) lead glazes: (*a*) fritted glazes, (*b*) mat glazes and their origin, and (*c*) copper red and blue iridescent glazes; (7) underglaze colors; (8) special glazes: (*a*) crystal glazes, (*b*) crackled glazes, (*c*) gilding, and (*d*) glazes for reduced firing; (9) artistic enamels; (10) enamels for cast iron and steel; (11) fritted glazes: (*a*) boron in glazes, (*b*) glazes without lead, (*c*) red uranium glazes, and (*d*) dissolubility of chromium, iron, and copper in glazes. The second part discusses (1) kaolins, (2) clay substance, (3) clay and its composition, and (4) ceramic masses for faience, stoneware, and porcelain. Numerous tables illustrate the book. M. V. KONDOIDY

PATENTS

Producing titanium compounds. FOORD VON BICHOWSKY. U. S. 1,828,710, Oct. 20, 1931. Method for producing titanium compounds which consists in stabilizing the interaction of nitric acid and titanium nitrogen compounds by carrying out the reaction in the presence of a phosphate ion.

Manufacture of opacifying oxides. LUDWIG WEISS. U. S. 1,830,581, Nov. 3, 1931. A process which consists in reacting the vapor of a water-soluble compound of the group of elements consisting of zirconium and tin with a hydrating substance and heating the product formed.

Obtaining barium aluminate. FRITZ ROTHE AND HANS BRENEK. U. S. 1,831,824, Nov. 17, 1931. Process for obtaining barium aluminate and barium silicate, comprising heating a mixture of materials containing heavy spar and alumina with silica impurity in the presence of steam in a nonreducing atmosphere to a temperature of at least 1100°C, the mixture containing such quantities of heavy spar that, in addition to barium aluminate, silicates of the type $BaSiO_3$ to about Ba_3SiO_5 are formed of the silica contained in the alumina-containing materials.

Treating titanium compounds containing iron. PEDER FARUP. U. S. 1,831,852, Nov. 17, 1931. The process which consists in subjecting the materials and a reducing agent to a temperature sufficiently high to reduce the iron to metallic state but not the titanium compounds, and treating the reduction product with sulphuric acid sufficiently concentrated to dissolve the titanium compounds present without dissolving the metallic iron.

Manufacture of titanium dioxide. W. W. TRIGGS. Brit. 358,492, Oct. 21, 1931.

General

Breakage of ware and means of avoiding it. P. VAN DIZK. *Klei*, **22** [24], 285–89 (1930); *Chim. & Ind.*, **25** [6], 1440 (1931).—The best ways to avoid the breakage of ware are as follows: (1) Clays suited for the given ware and its uniform preparation should be used; the resistance of the ware can be increased by appropriate mixtures of different clays. (2) As fat clays break, especially during drying, the clay should be weathered, made homogeneous, or mixed with sand or thin clay. (3) Interior tensions must be prevented. (4) The quantity of water must be carefully regulated as an excess causes breakage. (5) If the drafts in kilns are not adjusted properly, the humidity cannot escape. This can be remedied by regulating the gases of combustion. (6) The most difficult is the control of breakage during firing; the exact control of temperature in the kiln is therefore indispensable. (7) As this control is difficult in periodic kilns, the raw materials used must be especially carefully prepared. (8) The temperature must be decreased gradually during cooling of the ware. M.V.K.

Researches on the rotary kiln in cement manufacture. XXIX. Design of waste-heat boilers for rotary cement kilns. GEOFFREY MARTIN. *Rock Prod.*, **34** [22], 27–33 (1931).—M. gives thermodynamic formulas and calculations for waste-heat boilers, and tables and data on operating results. This is the concluding number of this series. For Part XXVIII see *Ceram. Abs.*, **10** [12], 823 (1931). W.W.M.

Fundamentals and economies in the clay industries. IX. ELLIS LOVEJOY. *Clay-Worker*, **96** [4], 218–22 (1931).—The various methods used in winning clays and mixing them before they are used in clay products are briefly discussed. Mining costs on the different types of operations are explained and a comparison of the various costs is made. Modern clay-winning machinery and operation thereof to overcome obsolescence are taken up. Methods used in underground mining of various types of clay are described and factors affecting the various methods are discussed. Clay tests that can be conducted at the mine or the pit to avoid factory losses are suggested. For Part VIII see *Ceram. Abs.*, **10** [12], 868 (1931). E.J.V.

Brick pavements advertised by radio. ANON. *Brick Clay Rec.*, **79** [9], 395 (1931).—The Metropolitan Paving Brick Co., Canton, Ohio, is sponsoring weekly radio programs to make the public brick-minded, and has coupled with it direct-mail and newspaper advertising. Local interest is enlisted by dedicating each program to a different city. The message of permanence, economy, and smooth riding surface of paving brick is being spread. E.J.V.

Profitable marketing of face brick. TYLER STEWART ROGERS. *Brick Clay Rec.*, **79** [9], 406–407 (1931).—Sound, common sense suggestions concerning the selling of face brick are offered in the discussion of three fundamental considerations: (1) selling methods of the industry in relation to buying methods, (2) elimination of unnecessary and extravagant selling costs, and (3) elimination or correction of certain wasteful situations in the distribution of face brick. E.J.V.

Professional training and problem of costs in brick plants. E. SCHONDORFF. *Ton-ind.-Ztg.*, **55** [82], 1151–53 (1931).—The importance of a professional training for the men to be employed in the brick industry is emphasized. A program of instruction is outlined. W.M.C.

Economics of the nonmetallic mineral industries. IX. Trademarks and brand names. RAYMOND B. LADOO. *Rock Prod.*, **34** [22], 52 (1931).—In selling sand-crushed stone and bulk mineral products, benefits may be had from establishing an identity for them. This is done by trademarks and brand names, a very common practice in the sale of most commodities. L. cites the value of this practice in merchandising certain rock products. The importance of carefully investigating this subject is pointed

out and sources of material are given. For Part VIII see *Ceram. Abs.*, **10** [12], 868 (1931). W.W.M.

Combined burners for firing waste fuels. R. C. VROOM. *Trans. A.S.M.E.*, **53** [14], 359–65 (1931).—Waste by-products of oil refining, formerly difficult of disposal, are now burned in special plants to furnish electric and steam power. This is made possible by the design of high-capacity burners, some liberating 100,000,000 B.t.u. per hour. V. describes a wide-range mechanical atomizer of the circulating type and the results of an installation at the Louisiana Station at Baton Rouge of the Louisiana Steam Products, Inc. The burners are successfully firing crude or lubricating (acid) sludge, soda bottoms, neutralized sludge, acid tar, wax tailings, and flux bottoms, in addition to fuel oil. E.P.R.

Automatic stokers increase efficiency of coal. HOLCOMBE PARKES. *Mfrs. Rec.*, **100** [13], 20–21 (1931).—The Norfolk and Western Railway has just completed exhaustive tests of two representative stokers using the low- and high-volatile bituminous coals. E.P.R.

Study of shovelling. G. TOWNSEND HARLEY. *Pottery Gaz.*, **56** [653], 1528 (1931).—A study of the right and wrong methods of shovelling was made. It was found that a shovel which held a 21-lb. load gave the best results. A careful analysis of the movements in shovelling was made and it was found possible to increase the tonnage per man from $8^1/_2$ T. to nearly 23 T. The tests also showed that it was possible to determine when to discard a shovel as being worn, the layout and spacing of chutes, the point at which to discontinue direct shovelling into chutes and resort to a wagon or wheelbarrow, the correct spacing of shovellers, the cost of delays or interruptions, the altered capacity of men as the working day progressed, the necessity for occasional rest periods, and the best means of instructing men and supervising their operations. E.J.V.

German standard method for testing boiler feed water. ANON. *Tonind.-Ztg.*, **55** [82], 1149–50 (1931). W.M.C.

Accident reduction. ANON. *Brick Clay Rec.*, **79** [9], 418–20 (1931).—The Los Angeles Brick Co. has materially reduced the number of accidents at its Alberhill, Calif., plant so that not one major accident has occurred in its six years of operation and only a score of "lost time" accidents have been experienced. Plant equipment and methods are described. Illustrated. E.J.V.

Future activities of this Society. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **10** [11], 333–34 (1931).—It is pointed out that when the collective coördination scheme for trade associations is brought into being, the SOCIETY will have to be a part of it, and consequently must be ready to shape its activities and policies into line with this scheme of affairs. E.J.V.

The Clay Products Institute of America. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **10** [11], 334 (1931).—The Institute is congratulated on the first issue of the *Journal of the Clay Products Institute of America*, and on its laudable purpose. E.J.V.

Honoring President Eskesen. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **10** [11], 331–32 (1931).—In this brief eulogy of Eckardt V. Eskesen, particular stress is laid on the fact that his attainments have been recognized by an exclusive group of architects who included him as one of five guests in one of their special excursions to Paris, and by the King of Denmark, who knighted him because of his humanitarian interest in Danish immigrants. The SOCIETY is honored to have such a leader. E.J.V.

Chicago World's Fair to have all-tile house. ANON. *Ceram. Ind.*, **17** [5], 400 (1931).—The Associated Tile Manufacturers, Inc., will construct an all-tile house as part of the housing exhibit at the Century of Progress Exposition, Chicago's 1933 World's Fair. W.W.M.

Special laboratory courses for clayworking trades at University of Sheffield. ANON. *Refrac. Jour.*, **7** [10], 445 (1931).—A special laboratory course for adult workers in the clayworking trades will be given under W. J. Rees and will consist of 20 demonstrations in the refractories laboratory of the University. E.P.R.

Abrasive men hold annual meeting. ANON. *Abrasive Ind.*, **12** [11], 20 (1931).—The annual meeting of the Grinding Wheel Mfrs. Assn. of the U.S. and Canada was held at the Buckwood Inn, Shawnee-on-the-Delaware, Pa., Sept., 1931. E.P.R.

Research discussed at Ohio meeting. ANON. *Brick Clay Rec.*, **79** [9], 424–28 (1931).—At the Ohio Ceramic Industries Assn. meeting at Ohio State Univ., November, 1931, the topics discussed included Lawrence County clays, drain tile manufacturers' activities, pyrometer tube research, effect of furnace slag on refractories, firing with stokers, and general research. Brief abstracts of the various papers are given. E.J.V.

Sale of clay products. ANON. *Brick Clay Rec.*, **79** [9], 386–97 (1931).—In spite of a general building loss of 22% and a drop of 43% in home building, clay products production has held up fairly well. Special shapes in refractories and clay sold showed gains over 1929, while the losses on clay building products were in the region of 20%. The aggregate value of clay products and nonclay refractories made in 1930 amounted to $300,695,931 compared with $406,507,775 for 1929 and $400,644,078 for 1928, representing losses of 26 and 25%, respectively. The total for 1930 was made up as follows: clay products other than pottery, $193,356,778, nonclay refractories, $21,758,070, and pottery, $85,581,083. E.J.V.

Sale of clay products to consumers. ANON. *Brick Clay Rec.*, **79** [9], 398–99 (1931).—Manufacturing plants engaged primarily in making clay products and nonclay refractories made $153,317,000 worth of sales to consumers, or 50.8% of the total of $302,136,000. Sales to dealers amounted to 42.7%, or $129,079,000, and the other 6.5%, or $19,740,000 worth, was sold to their own wholesale branches for resale to dealers and consumers. E.J.V.

Clay and clay products in Canada. ANON. *Pottery Gas.*, **56** [653], 1546–47 (1931).—In 1930 there were 205 firms with a total capital investment of $37,530,742, employing 5867 persons, operating in the clay and clay products industry. The sales value of $10,593,578 of products sold during 1930 showed a 23.8% decrease from 1929. The value of sewer pipe sold during 1930 was $1,721,815, coarse earthenware, stoneware, and other pottery made from domestic clays, $296,618, and fire brick, fire clays, and special fireclay blocks and shapes, $350,892. The output of goods made from imported clays amounted to $2,978,143, or 12% less than in 1929. Among products made from imported clays were porcelain insulators, valued at $1,957,523, firebrick stove linings and similar refractories worth $298,945, and pottery, sanitary earthenware, etc. Imports of clay and clay products were valued at $10,196,681, compared with $12,159,566 in 1929, while exports of clays, building brick, porcelain insulators, earthenware, and other clay manufactures were valued at $449,120, compared with $375,506 in 1929. Interest is being displayed in the question of china tableware manufacture in Canada, the raw materials being available in the Dominion, though not in close proximity to the principal centers of population. E.J.V.

Canadian glass production. ANON. *Pottery Gas.*, **56** [653], 1509 (1931).—The glass production in Canada during 1930 was valued at $12,191,752, a decrease of 21% from the record set in 1929. Sixty-two plants engaged in manufacturing glass or glass products reported a working capital of $15,962,392, and employed 3388 persons. E.J.V.

Russian National Porcelain Factory. ANON. *Pottery Gas.*, **56** [653], 1551 (1931).—The Leningrad Porcelain Factory, established in 1744, was converted into a ...chnical porcelain and optical glass factory during the War, but reverted in 1917 to its original

purpose, the production of art porcelain. Other analogous factories were collected into a State Trust called the Prodasilikat. E.J.V.

BOOKS

Fuel Economy Review. ANON. *Refrac. Jour.*, **7** [10], 461–62 (1931).—The Federation of British Industries has recently issued a new edition of the "Fuel Economy Review," Vol. X, in which the power problems of industry are discussed by expert authorities. E.P.R.

History of the City of Stoke-on-Trent. Part I. Compiled by ROBERT NICHOLLS. Wood, Mitchell & Co., Ltd., Oriel Works, Hanley. Reviewed in *Pottery Gaz.*, **56** [653], 1550 (1931).—This work is to be published in separate parts and Part I, which has just appeared, is specially devoted to "The Potteries," taking the form of a booklet of 70 pages of text and a dozen or more illustrations, all of which are of archaeological interest. Much of the material is based on the history published by John Ward in 1843, with some new material added. E.J.V.

China Year Book, 1931. ANON. North China Daily News, Shanghai, 1931. Price $10.00. Reviewed in *Times Eng. Supp.*, **28**, 497 (1931).—This is an encyclopedic work on the peoples and industries of China as they are today. H.H.S.

PATENTS

High-strength ceramic composition. THOMAS S. CURTIS. U. S. 1,827,838, Oct. 20, 1931. A ceramic composition consisting of corundum and cobaltic oxide.

Composition for ceramic uses. THOMAS S. CURTIS. U. S. 1,830,934, Nov. 10, 1931. (1) The process consists of subjecting pyrophyllite to reduction by heat, cooling the reduced mass quickly to prevent reoxidation, and mechanically comminuting the resulting product. (2) A composition comprising a mineral concentrate from which substantially all undesirable materials associated therewith have been removed and in which alumina and silica are retained in proportions of approximately three of the former to two of the latter, the mineral concentrate being finely comminuted substantially pure concentrated residuum obtained from the pyrochemical reduction of pyrophyllite ore.

Mineral surfacing and mineralized roofing. ARTHUR W. SEWALL. U. S. 1,831,469, Nov. 10, 1931. (1) A method of preparing decorative granular surfacing material which includes first crushing vitrified ceramic material and then superficially glazing the individual particles with decorative coloring. (2) A surfacing material including vitrified granules individually superficially glazed with a fused color glaze, substantially wholly coating the granules.

Glazed-rock granule surfacing and roofing surfaced therewith. GEORGE H. BROWN. U. S. 1,831,784, Nov. 10, 1931. A process which comprises wetting refractory mineral granules with an aqueous glaze solution, drying the granules, and fusing the added material into a glaze coating on them.

Treatment of siliceous materials. P. SPENCE & SONS, LTD., AND A. KIRKHAM. Brit. 357,993, Oct. 14, 1931.

Mortar stable on heating. REINHOLD & CO. Ger. 517,959, Feb. 22, 1930; *Feuerfest*, **7** [8], 122 (1931).—The mortar consists of a mixture of carbonates or oxides of alkaline earth with heavy metal oxides. Calcium carbonate or calcium oxide can be used for the first group, while iron oxide, copper oxide, and manganese-zinc oxide can be used as heavy metal oxides. The mortar can be mixed in three ways: (1) mixed dry and water added afterward, (2) every compound is separately mixed with water and afterward mixed, or (3) one of the components is mixed with an appropriate addition of water and then the other dry components are added. M.V.K.

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BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions, and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

WALTER P. SUTER MYRTLE M. FRENCH	Art	A. E. R. WESTMAN DOROTHY A. TEXTER	Refractories	HOWELLS FRÉCHETTE	Structural Clay Products Materials and Equipment
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Vol. 11 **January, 1932** **No. 1**

EDITORIAL

FIGHT

"Fight! Fight! Fight!" shouted millions of football fans on nearly every school yard and campus. The aged, the kids, the professors, the students, the men, the women, the aristocrats, the lowly, the free, and the Sing Singers demanded that their team fight with all their available brawn and brains.

No meanness in that; no ill temper; simply a contest.

Persons, corporations, political parties, and governments contend forensically and finally make a compromised formal agreement without developing personal ill will. The narrow-minded, the conceited, the poor losers, and the dishonest think and speak of contentions as personal and unfriendly. Generally, such a perverse notion is held by those who have a selfish interest in the issue and are themselves contentious.

If ever there was need for each person to bury deep his selfish and dishonest "imps" it is now when all are contending and many are losing in their struggle for livelihood.

Yes, fight! fight! fight! but with heads up, without malice, and according to the rules.

It is a fact that "only in union there is strength." Being in unison and joint subscribers to procedure rules it is necessary that each shall equip himself mentally and physically to the best of his capabilities and play the game with all the "fight" that is in him. The success of the union depends on the attainments of each of its constituent members, but each member must abide by the rules in fullest honesty, friendliness, and team work.

Trade associations are being disbanded in these times of economic stress. Needed always, but needed more in such times as these; yet their members resign. How can thinking, honest men justify withdrawal of their support from their trade and technical associations? Associations are not luxuries; they are team organizations without which the largest possible success is impossible for us either collectively or individually.

Fight! Fight! Fight! But fight as a team and according to association rules.

ACTIVITIES OF THE SOCIETY

EDUCATING THE PUBLIC TO DEMAND THE BEST IN AMERICAN CREATIVE ART[1]

By Walter P. Suter

It was my privilege to attend last year's meeting at Toronto and I was deeply impressed with the amount and type of research being conducted by the Society as a whole and the thorough, intimate study pursued by the Art Division. Ever since, I have become more and more conscious of the fact that with the public there exists an amazing contrast to this attitude. In other words, the ultimate buyers of the various products manufactured by the members of this Society are still ignorant of the potential beauty and value of fine ceramic creations. This may explain their lack of appreciation and interest. The seeming preference for imported ware is probably due to the assumption that it would not be imported if it were not good and worth while to buy.

This situation is, or will have to be, of the utmost interest to the Society and to the Art Division in particular. It also seems that the time for definite action has come, and it is up to us to decide whether we shall continue to stand back and regard the situation as unfortunate and inevitable, or concentrate our united efforts and do something about it.

There can hardly be any doubt as to our answer since we all are closely connected with ceramics in one way or the other and are, directly or indirectly, vitally interested in the prestige and welfare of the industry.

The answer to the question, "What can we do about it," however, is not so readily definable. It will be necessary, first of all, to analyze our position, our strength, and our ability and to consider the problems as well as possibilities before us.

The following points present themselves at once:

(1) We are not a permanent body, but gather only once a year. All work, therefore, will have to be carried on individually by the members.
(2) We must secure the coöperation and active support of manufacturers in order to carry a constructive program forward.
(3) The foremost issue on the program should be a sustained campaign to educate the public and, to use a shopworn term, to make the people "ceramic-minded" by means of exhibitions, magazine articles, and, chiefly, superior products.

Vague and simple as this program may appear, it would, if carried out, become an issue of considerable importance. But it also means action, and action means *now*.

If there are obstacles preventing us from taking action, let us investigate and find out what they are and by what right they exist.

True, we gather but once a year, but this does not mean that our meetings should, symbolically speaking, become a "wailing wall of Jerusalem" where each one empties his troubled heart and tells the other fellow of his sorrows and difficulties in business encountered during the year. Consoling as it is to find that one is not alone with one's doubts and set-backs, nevertheless, it does not remedy existing conditions. But if we come together to urge each other on to do better and finer work, to find inspiration or, perhaps, just criticism, and to unite our efforts in a common cause, we go back not only consoled but charged anew with the will to do our humble share in making the ceramic industry of this country stronger and more noteworthy in its achievements.

Over a long period of years patient research has perfected our technique and tools and has opened for us unlimited possibilities. We can truthfully say that we are pre-

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Art Division).

pared to act. This is well, as there seems to remain a vast amount of missionary work to be done, and I believe we have the knowledge, the training, and the enthusiasm to do it.

The work we propose to undertake must broaden itself out into a widespread move-

SCHEDULE FOR ANNUAL MEETING AMERICAN CERAMIC SOCIETY, WILLARD HOTEL, WASHINGTON, D.C.

ROOMS		GRIDIRON	PALM	CABINET	LARGE BALL	SMALL BALL	FAIRFAX	WILLARD	PRESIDENT SUITE	GENERAL
Sun. Feb. 7	A.M.									
	P.M.	Trustees								
	NIGHT	Trustees								
Mon. Feb. 8	A.M.	Trustees								
	P.M.			Fellows						
	NIGHT				Materials and Equipment Division Frolic and Dance, Washington Hotel Rose Room, 9:00 P.M. (Purdy's fifty daughters dancing)					
Tues. Feb. 9	A.M.		Enamel	Glass	Refractories	Structural Clay Products	Art Terra Cotta	White Wares	Materials and Equipment	
	P.M.									Trip to U.S. Bureau of Standards
	NIGHT							General Meeting		General Meeting, 8:00 P.M.
Wed. Feb.10	A.M.	Art	Enamel	Glass	Refractories	Structural Clay Products	Terra Cotta	White Wares	Materials and Equipment	
	P.M.									12:30 Reception by Pres. Hoover Trip to Mt. Vernon
	NIGHT						Reception	Dance		7:00 P.M. Division Dinners 9:30 P.M. Pres. Eskesen Reception Dance 9:30 to 1:00 A.M.
Thurs. Feb. 11	A.M.	Art	Enamel	Glass	Refractories	N.B.M.R.F Structural Clay and Terra Cotta		White Wares	Materials and Equipment	
	P.M.			Fellows						Trips to Galleries, Institutes Cathedral as per election
	NIGHT									7:00 P.M. Ceramic School Dinners
Fri. Feb. 12	A.M.				Leave for Baltimore, 9:10 A.M.					
	P.M.									
	NIGHT									

ment in order to be successful and this is unthinkable and futile without the active support of at least a few manufacturers. They should be eager to offer us their coöperation as we are not asking a favor, and they should consider it a privilege to avail themselves

of our services. The work done by the Art Division within the last four years alone is ample proof that we are not groping around blindly, but that we have incessantly and consistently striven to bring about a higher standard in design and craftsmanship in order to influence and dominate the market in favor of our domestic products.

It is hardly conceivable that there should be manufacturers who would not endorse a movement to educate the public, especially since it is a common truth that the attitude of the ultimate buyer toward any product is preëminent.

Our public has become more discriminating in buying costly silk or modern household conveniences, again appreciates fine rugs, and understands the beauty and appeal of silver and pewter. Even the homes built today have an air of individuality and their layout and design reflect the wishes and personality of the owner. In some of these homes ceramic products are appreciated and perhaps even cherished, but to the great majority ceramics seems to remain a book with seven seals.

"But how can this be!" the tile and terra cotta manufacturers might say, "Did we not continually advertise the practical and lasting qualities of our product?"

Yes, but the linoleum, asbestos, and cast-stone manufacturers did the same. What the public as a whole has not been told is the elementary truth, namely, that any ceramic product is as genuine and time-honored a medium as bronze, copper, silver, or wood, be it in the form of tile, terra cotta, pottery, or tableware.

This is not new to us who are conversant with the subject, but time and time again, I have seen people become astonished and delighted upon being told a few of the technical and characteristic principles inherent every piece of ceramics. Consequently, a simple jar or a plate attained in their eyes a new significance, especially as they had never fully realized that a common brick, a fine piece of majolica, and the most exquisite dinnerware are all, basically, most intimately related.

In this respect, a traveling exhibition showing practically the full line of ceramic products from hollow tile, drain pipes, and structural terra cotta to the most delicate pieces in glass, tableware, and pottery, and accompanied by photographs showing some of the pieces in various stages of execution would have an enormous educational value.

This may be a bold idea, but nothing could better impress upon the public the importance and character of ceramics. It would tend to instill pride and respect for this large domestic industry and, if given the right publicity, might be of as much benefit to all concerned as a protective tariff. We can also feel certain that we shall have the help, advice, and coöperation of those organizations who sponsored the International Ceramic Exhibition, provided we approach them with a definite project.

Magazine articles, fascinatingly written and appearing in the various popular magazines, would be a powerful means by which the public interest could be stimulated. I am convinced that editors would welcome contributions coming from women and men who know the subject of their study intimately and not only in a superficial manner. In fact, it is a pity that some of the papers read here are not given much wider publicity instead of appearing in trade journals only which, incidentally, is a good deal like carrying coals to Newcastle.

Once the public has learned to appreciate and to understand the value of good, genuine work, plagiarism will be greatly discouraged if not eliminated. As long as pirating and unscrupulous copying of designs are substituted for creative work, we can not blame the public for buying imported ware of original and exclusive design. There is nothing quite as suicidal as to steal one another's patterns, change them a bit in size or color, and throw them on the same market, if possible, a little cheaper. By this practice the public is forced to believe that this is the best we can offer; and this at a time when we can truthfully say that we have the craftsmen and the equipment to equal the best

European creations. Why not so tell the public? Or better yet, why not furnish convincing proof of our ability?

Once we have created a public demand and preference for American ceramics, the average manufacturer will be forced out of his rut and he will have an opportunity to dominate the domestic market if his product is and remains superior in design and workmanship. To accomplish this he will have to secure the assistance of trained designers. The latter, therefore, will find doors open to them which are now closed.

In the belief that the goal is well worth our most earnest endeavor, let us approach its realization with enthusiasm. Let us appoint a committee to study conditions, ways, and means. Let us individually exploit our connections and affiliations in order to reach the public. But, above all, let our own work and our sincerity be our vindication.

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Art Division Program[1]

The special function of the Art Division of the AMERICAN CERAMIC SOCIETY has been to promote the development of beauty and usefulness in the design of ceramic products.

A somewhat new but legitimate activity for the division would be the promotion of a campaign to increase public knowledge of and respect for the artistic quality of American ceramic products. The preference for imported ware is in part the result of a traditional belief that true quality in art must come from abroad. It is not generally realized how many fine things in ceramics are now being made in America.

Three ways of attempting public education in regard to this point seem possible:

(1) By means of carefully selected traveling exhibitions of the best available products of both industrial and individual workers. The products of Denmark, Sweden, Austria, France, and other European countries have been well shown in traveling exhibitions which have been given wide publicity and dignified presentation in the art museums of the country, but no such opportunity for adequate display of their best products has yet been offered to the ceramic producers of the United States.

(2) By means of well-written magazine articles showing and describing fine American products, not exploited from a sales standpoint but presented because of their value as works of art.

(3) By means of radio talks on ceramic products similar to those given last year by Professor Nash over WLW.

STUDIES IN SHAPE CONSTRUCTION. SERIES III[2]

BY PAUL BOGATAY AND ARTHUR E. BAGGS

The third series of drawings dealing with dinnerware shapes is submitted by the General Education Board, Research in Tableware Design.

The purpose of this series is to illustrate a simple, systematic method for the development of suitable ceramic shapes by varying the proportions of single fundamental forms or combinations of related forms.

The type forms used in this study are those selected by Alexander Sandière of Sèvres.

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[1] Adopted at Cleveland, 1931.

[2] For series II see *Bull. Amer. Ceram. Soc.*, **10** [9], 295 (1931).

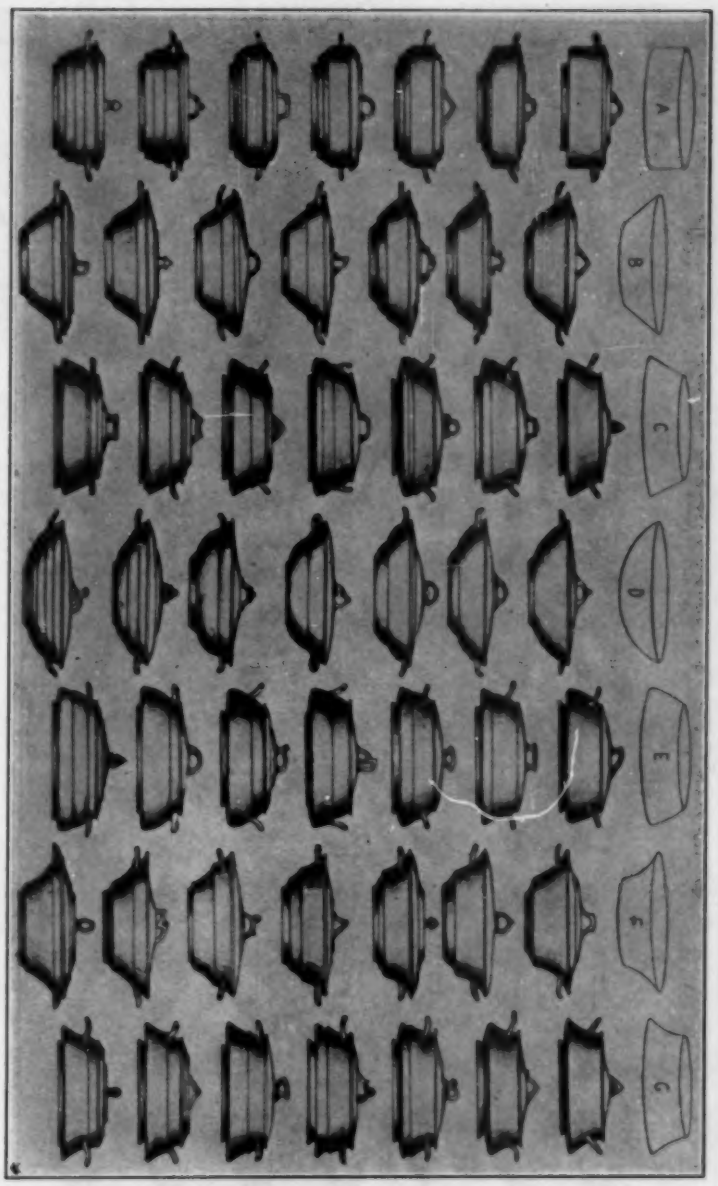


FIG. 1.—Casseroles: Illustrating seven possible variations of each of seven basic forms.

They are known as the "Sandière blocks." Seven basic forms as shown at the top of each chart cover practically all fundamental shape types.

Each chart deals with one of the important units of a dinner service and shows each of the type forms varied in proportions through several changes with slight

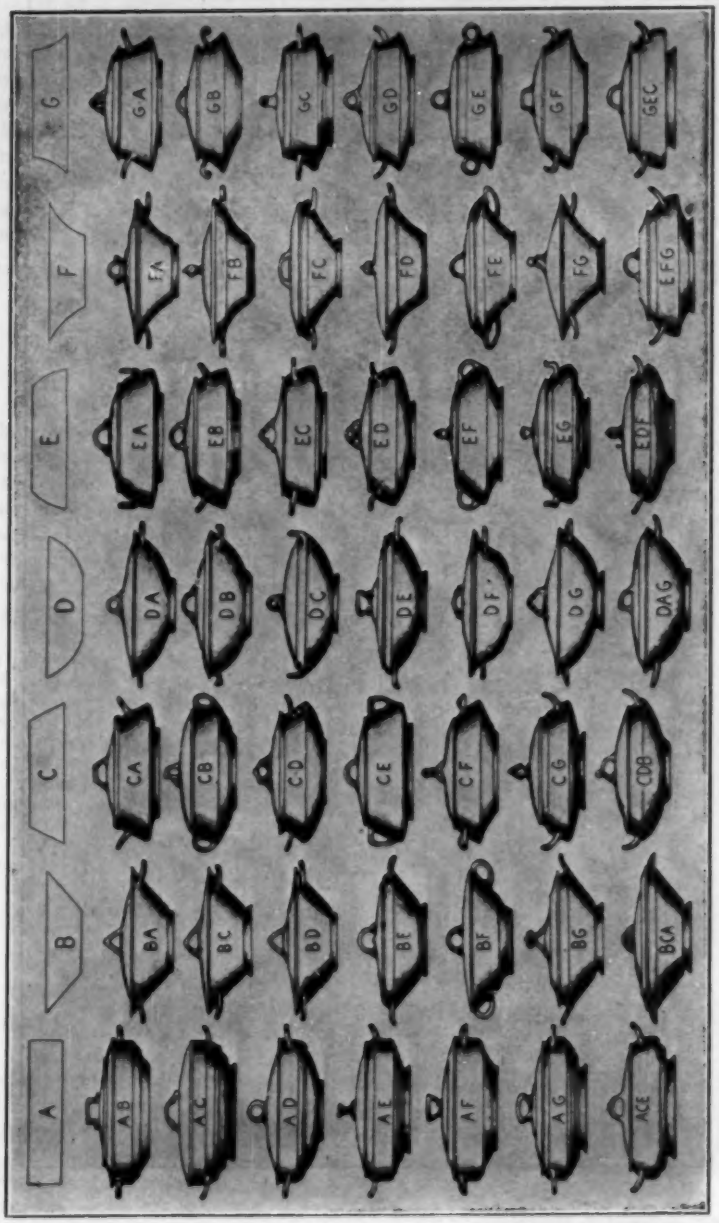


FIG. 2.—Casseroles: Illustrating combinations of two or more basic forms in varying proportions. The forms used are indicated by letters on each drawing.

modifications as dictated by the requirements of practical usefulness and the processes of manufacture.

A description of the charts is given, each referring to its accompanying illustration.

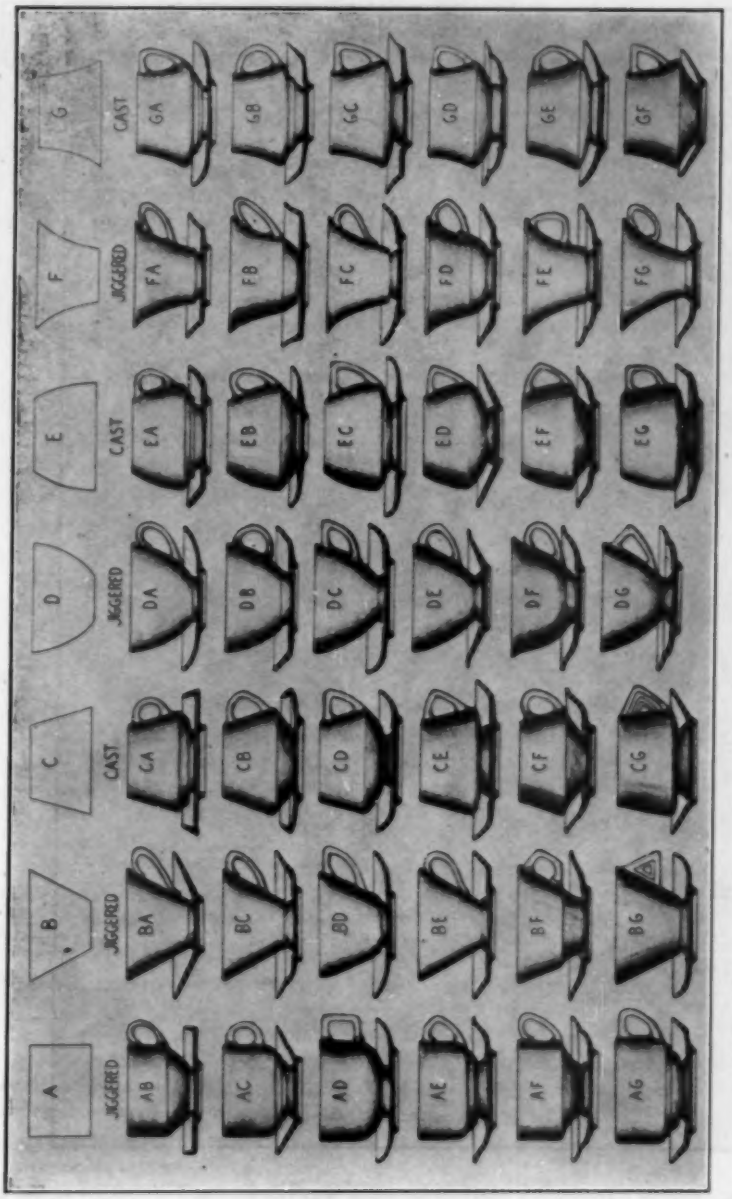


FIG. 3.—Teas: Combinations of two basic forms as indicated by the lettering of the drawings.

These charts are offered not as a complete study of possible shapes, but as a demonstration of a useful, orderly method of attack on the problem of shape construction. The possibilities are endless for combinations of basic forms and their refinement to meet practical limitations. Not all shapes developed in such a study will be satisfactory, of

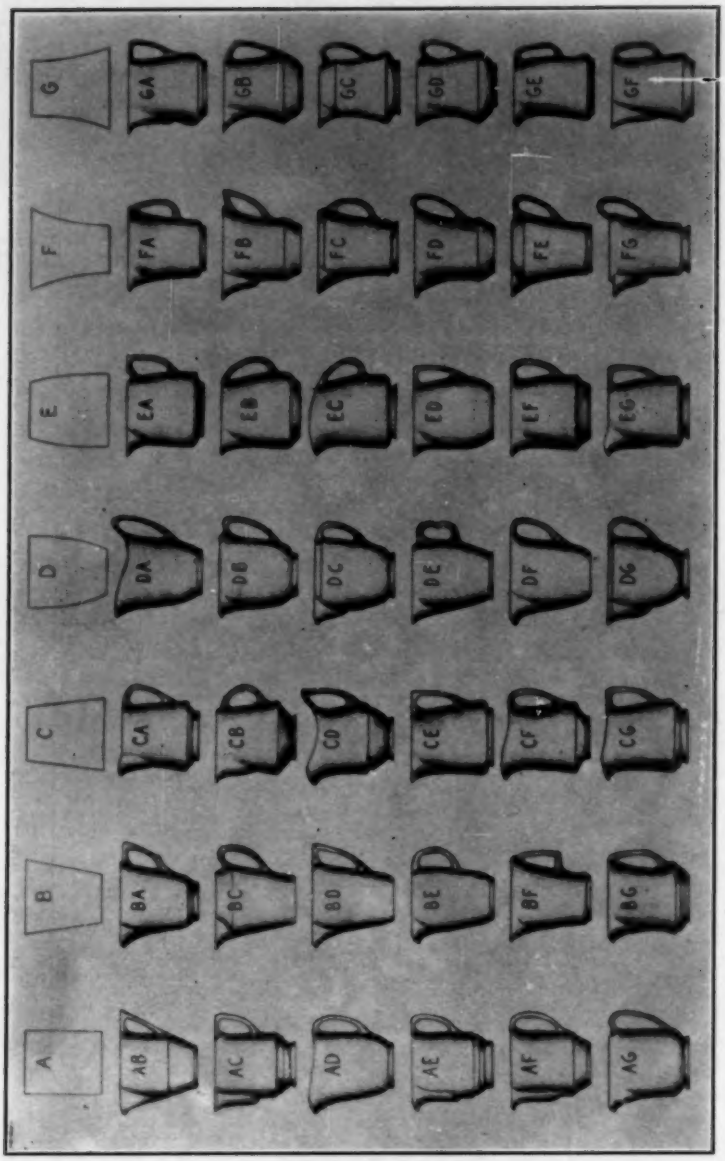


FIG. 4.—Jugs: Combinations of two basic forms as indicated by the lettering of the drawings.

course. But as a systematic method for shape analysis and as a stimulant to the mind of the designer in following each basic form through to its ultimate possibilities, this procedure has great usefulness.

It will be much appreciated by those who are working on these design studies if manufacturers and others interested will offer comments, criticisms, and suggestions regarding the drawings which have been submitted.

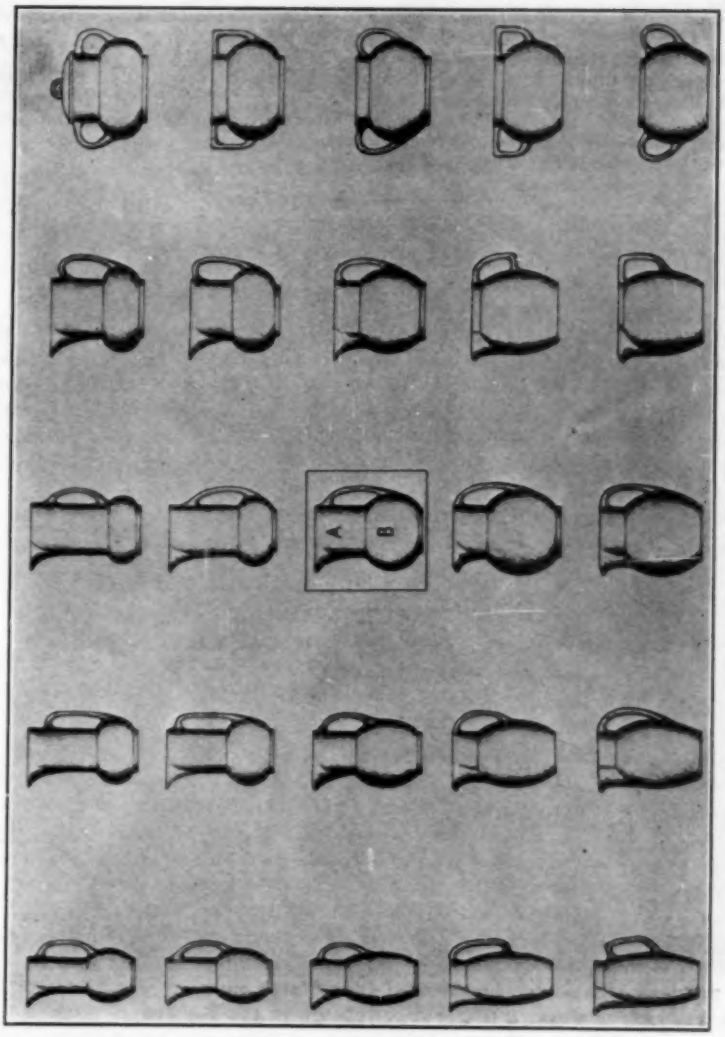


FIG. 5.—Jugs, creams, sugars: Varied combinations of cylinder A and truncated sphere B with changes in width, height, proportion, and line. This method may be applied to any form or combination of forms for purposes of refinement or development of related forms.

The object of the study is to serve the industry. To that end, it is important that industrial men should help steer the study in lines of greatest usefulness to all by making known their impressions and suggestions regarding the work which is being done.

OHIO STATE UNIVERSITY
SEPTEMBER 24, 1931

ENAMEL DIVISION NOMINATIONS

The Enamel Division Committee on Nominations which consists of R. D. Wells, Chairman, Erwin Sohn, and F. B. Mahoney has presented the following nominations for officers of the Division for the year 1932:

Chairman: W. V. Knowles, Titanium Alloy Mfg. Co., B. F. Keith Bldg., Cleveland, Ohio.

Secretary: W. N. Harrison, Bureau of Standards, Washington, D. C.

Nominating Committee: B. T. Sweely, Baltimore Enamel & Novelty Co., Baltimore, Md.; B. A. Rice, Pfaudler Co., Rochester, N. Y.

Councillors: B. A. Ludlum, Union Sanitary Works, Noblesville, Ind.; J. A. DeCelle, Chicago Hardware Foundry Co., North Chicago, Ill.

LOCAL SECTION NOTES

St. Louis Section

A meeting of the St. Louis Section of the AMERICAN CERAMIC SOCIETY was held at the Melbourne Hotel, St. Louis, Mo., on November 27. Following dinner, David E. Gray, chief engineer of the Corning Glass Works, Corning, N. Y., gave an address on "Technical Glassware." This talk was accompanied by lantern slides as well as by an exhibit of glass products. A second address was given by George Aurien, manager and superintendent of the Mississippi Glass Co. of St. Louis. Mr. Aurient alked on "The Modern Method of Rolling Glass."

An attendance prize was offered by the Winkle Terra Cotta Co.

Frederick E. Bausch is Chairman of this Section and J. W. Wright is Secretary.

NECROLOGY

Raymond Barker Gilmore

Members of the AMERICAN CERAMIC SOCIETY have been saddened to learn of the sudden death of Raymond Barker Gilmore. On December 4, while on a business trip near Clearfield, Pa., he went out hunting with a party of men, although he himself was not participating in the hunt. A stray bullet struck him, and although he was badly wounded he might have won his fight for life if double pneumonia had not developed. His death occurred on December 11.

Raymond ("Pete") Gilmore was born in Fletcher, Ohio, September 7, 1896. He spent his childhood days in Fletcher, and when ten years old moved to Piqua, Ohio, with his parents and older brother.

After finishing high school, he attended Ohio State University where he took his degree in ceramic engineering. He held positions with the Vesuvius Crucible Co. at Swissvale, Pa., the Columbus Station of the Bureau of Mines, the Laclede-Christy Clay Products Co., St. Louis, and the Carborundum Co. of Niagara Falls, N. Y.

For the past five years he had been associated with the North American Refractories Co. of Cleveland. To this latter work he devoted the best energies of his life and his enthusiasm and interest in the affairs of his company not only increased the value of his services to the company but strengthened and widened an already large circle of friends.

In 1918 he became a member of the AMERICAN CERAMIC SOCIETY and since that time had identified himself actively with the affairs of the Refractories Division, serving on various committees. At the time of his death he was Vice-Chairman of the Refractories Division and was in line for the office of Chairman for the coming year.

He is survived by his wife and three young children, Mary, Raymond Merton, and Donn Carleton, and also his father, Addison C. Gilmore.

"Pete" was fellowship minded; he shared his time, thoughts, and energy with others. At home he playfully shared in the affairs of his children; he was solicitous of his wife's people and friends; he was active in church, lodge, and community affairs; he always had time for thoughtful and active participation in the affairs of the AMERICAN CERAMIC SOCIETY.

A quiet, smiling, cheerful, unassuming, yet aggressive member of this SOCIETY is no longer with us in person but his spirit will continue with the many who knew "Pete"

RAYMOND B. GILMORE

Gilmore, and the results of his works will be lasting. Young though he was, he left a positive impress for good.

We mourn with his wife, three children, and father; we are sad with his business associates, but as "Pete" would have it, we are happy that he had been one of us and that our memory of him is blessed.

LeRoy Himes Minton

LeRoy H. Minton died at his home in Metuchen, N. J., December 15. Mr. Minton had been in attendance at the banquet of the Ohio Society in New York City the previous evening and although he complained of a headache he did not seem concerned about the condition of his health. He expired suddenly the next afternoon before

medical aid arrived. The funeral was conducted at his home in Metuchen on Friday, December 18.

Mr. Minton was born in Covington, Ohio, in 1882 and was graduated from Ohio

L. R. H. MINTON

State University in 1904 with the degree of M.E. in ceramics. Following his graduation he was employed as Ceramic Chemist at the Mosaic Tile Company at Zanesville, Ohio, and the Perth Amboy Terra Cotta Company at Perth Amboy, N. J., and as Superintendent of Plant No. 2 of the General Ceramics Company at Metuchen, N. J. He was

made General Superintendent of that company in 1921 from which position he resigned in 1928 to engage in ceramic consulting practice.

Mr. Minton joined the AMERICAN CERAMIC SOCIETY in 1906, was elevated to active membership in 1916 and as a Fellow in 1930. He served as President of the SOCIETY during 1920–1921 after having served on the Board of Trustees for several years. He was also Chairman of the Committee on Publications for several years.

His contributions to ceramic literature were many and valuable but probably his most effective ceramic work in a public way was in organizing and managing in an executive capacity when the AMERICAN CERAMIC SOCIETY was emerging from the strictly scholastic into an industrial technical society.

As officer and committeeman and finally as President of the New Jersey Clay Workers Association and continuously since then as member of the executive committee of that Association, Mr. Minton made such a record of works efficiently accomplished that he has an everlasting place in the ceramic history of New Jersey.

Internationally, nationally, and at home, Roy Minton was known as a ceramist who gave largely of his energies and talents to the advancement of the ceramic professions and industries. He had earned a large place in the world's ceramic affairs.

Much more could be said of the things accomplished by Roy Minton. It was not alone in these things that he made distinctive impresses. In his home life, in church, in fraternal societies, and in civic and community affairs, wherever he contacted with men, Roy Minton had a moral leadership that was inspiring. His sterling integrity could never be doubted. He gave much thought to the welfare and happiness of all with whom he contacted.

He was positive, sure of himself, and when assured of the justice of the program or activities on which he was engaged, he fought with an honest above-board cunningness with which opponents could not cope. He most often won in such contests because he was diligent in obtaining victories. For most men this would result in personal enmities but with Roy Minton such were never harbored by him or by those with whom he contested.

His was a leadership and an influence in affairs on which organizations such as the AMERICAN CERAMIC SOCIETY was founded and by which it will be continued. Roy Minton's influence will continue with this SOCIETY because his works for it are enduring. Gone in body, his spirit will remain.

THE SECRETARY'S CORRESPONDENCE

2525 N. High Street
Columbus, Ohio
November 27, 1931

Mr. R. A. Heindl
Bureau of Standards
Washington, D. C.

My dear Ray:

Bole's Letter November 23
Rueckel's Proposed Paper on Various Gases Employed to Flood Dry-Press Mold Boxes

It has always been the intent to develop our Annual Meeting programs, regardless of all other considerations, along the lines devised by the several Division Committees which, in their opinion, would make the Annual Meetings most valuable to the delegates

attending, and in interest of the SOCIETY's efforts to promote the ceramic arts, science, and technology.

Contrary to what has appeared to be a general impression, the Annual Meeting programs, at least during the past ten years, have not been designed to produce copy for the *Journal of the American Ceramic Society*. If the SOCIETY's major purpose and objective were to publish, I for one would not be interested in the SOCIETY.

The SOCIETY maintains the *Journal* for publication of reports of original researches which are not to be published elsewhere. It maintains the monthly *Ceramic Abstracts* for the purpose of keeping the members informed of everything that is published the world over of interest to ceramists. The *Abstracts* will cover the papers published elsewhere than in the *Journal of the American Ceramic Society*.

It is not at first apparent, but nevertheless it is a fact that the more liberal the policies the more necessary it is to have constitution, by-law, and rule regulations. The axiom that "In law there is liberty" applies to all human activities including technical societies. It is idle to assume that rules made by the SOCIETY and placed in the Constitution or rules made by committees should be anything other than provisions for larger exercise of liberty.

The rule in the Constitution says that all papers, etc., presented at any Meeting of the SOCIETY shall become the property of the SOCIETY, subject to disposition by the Publications Committee. The Publications Committee has ruled that no paper shall appear in the *Journal of the American Ceramic Society* which will appear elsewhere in English.[1] There is no intent to disregard the proprietorship of the SOCIETY over papers presented at the Annual Meeting, but at the same time there is no intent on the part of the Publications Committee, as I understand it, to prevent Divisions developing their programs in any manner in which they see fit, providing an understanding is maintained by all parties that are affected by the provisions in the Constitution and the Committee Rules.

You can accept papers, the publication rights of which are reserved by Engineering Experiment Stations or Bureaus, provided you have the consent of the Publications Committee in each case.

Yours very cordially,
ROSS C. PURDY, *General Secretary*

2525 N. High Street
Columbus, Ohio
November 27, 1931

Mr. H. M. Kraner
Westinghouse Electric & Manufacturing Co.
Derry, Pennsylvania

My dear Hobart:

Yours November 24 to Paul E. Cox
Reprinting in Journal of This Society Papers from the Journal of Society of Rheology

This SOCIETY will not publish papers which will appear elsewhere in English. This rule is not peculiar to this SOCIETY; it is the rule of similar societies. The basic idea is that money raised by dues, contributions, subscriptions, or appropriations for the pur-

[1] See *Bull. Amer. Ceram. Soc.*, **10** [12], 345 (1931).

pose of research and the promotion of research activities should be spent as economically as possible, and since the several societies now have extensive abstracts, there is no need for publishing a given article twice.

The articles in the *Journal of the Society of Rheology* are abstracted for the *Ceramic Abstracts* which our SOCIETY publishes. Should the reader find interest through the abstracts of a given article, he can procure the article from the agency which publishes it.

The SOCIETY ten years ago had the rigid rule, supported by copyright, that no trade journal or other publication could reprint any article which appeared in the *Journal of the American Ceramic Society*. This rule was changed ten years ago and a blanket permission was given to the ceramic trade journals to reprint any article from the *Journal of the American Ceramic Society*, provided due and full credit was given and exact reference to the *Journal* made.

So far we have mentioned only committee rules and procedures.

There is a rule in the Constitution of the SOCIETY which states that all papers, addresses, committee reports, etc., presented before the SOCIETY or any organized part of it, shall be the property of the SOCIETY, subject to disposition by the Publications Committee.

A custom has developed permitting the Division program committees to arrange for papers and addresses, with the understanding that they are to be released immediately to the author for disposition other than publication by the SOCIETY. This custom has, in principle at least, involved the securing of permission by the Publications Committee prior to the listing on the programs of the release of the paper to the author. The General Secretary being the General Program Chairman and at the same time Editor, representing the Publications Committee, these cases have been handled by agreement with the Division Program Chairman and myself as General Program Chairman; they have not been made a case before the Publications Committee.

Because of the recent ruling by the Publications Committee to the effect that they will not consider the publishing of any paper which will appear elsewhere in English, there will be a larger number of cases involved, and a more analytical judication required in the acceptance of papers for the Annual Meeting program by the Division Program Chairmen. These cases will involve mostly the papers from universities and federal bureaus.

The policies and aims of the AMERICAN CERAMIC SOCIETY, as stated in its Constitution and By-Laws, and in its committee rules, are intended to be very liberal, rather than autocratic. The promotion of ceramic education and research and the proving of the value of these to industrial ceramics is the purpose of the SOCIETY. To this end the SOCIETY has promoted the bureaus, research stations, and ceramic departments in universities. There is no reason to assume that this SOCIETY would seek to curb the activities and the growth of these ceramic educational and research agencies. There is, however, the necessity for a mutual regard for the welfare of and by all of the agencies which are devoted to the promotion of ceramic arts, science, and technology, including this SOCIETY. It is assumed that the Board of Trustees, the Division officers, and the several committees of the AMERICAN CERAMIC SOCIETY will be glad to consider with the educational and research agencies any and all matters that effect the most successful prosecution of the ceramic arts, science, and technology.

The Division Program Committees will this year have to take up with the Publications Committee in each case the question of waiving the releasing of the paper to each author, respectively.

Yours very cordially,

ROSS C. PURDY, *General Secretary*

Derry, Pa.
December 10, 1931

Publications Committee, AMERICAN CERAMIC SOCIETY:

Gentlemen:

We have received information from Professor Watts in regard to the difficulty and embarrassment he is experiencing on account of the new policy of the AMERICAN CERAMIC SOCIETY, that any material presented at the meetings or published through the AMERICAN CERAMIC SOCIETY cannot be published in English thereafter, and also that the AMERICAN CERAMIC SOCIETY will not publish papers that will appear elsewhere in English. Professor Watts refers particularly to some work on feldspar which he is at present doing at the University, which he would like to report at the coming Meeting and have published in the *Journal* so that the White Wares Division may have the benefit immediately of what has been done so far. He desires, however, to use this material and that obtained subsequently in a complete bulletin on feldspar, or possibly in a textbook. This undoubtedly would mean that the material would not be presented in the same manner when it is published in complete form. In this case he does not feel that he can present this progress report at the coming Meeting if doing that prohibits him from using the material later on.

In addition to this situation, he also refers to a paper by Paul F. Collins entitled "Auxiliary Fluxes in Ceramic Bodies" which we believe he covered in a letter to you dated November 20. This particular paper was presented at the Cleveland Meeting and it was so favorably received that the White Wares Division made a formal request at that time that this paper be published as soon as possible because it would be of such great interest to a large part of the Division. In view of this action by the Division, it seems particularly unfortunate that the Collins paper will not be published if the present publication policy is adhered to.

We believe that this publication policy will work to the detriment of the SOCIETY if it is adhered to exactly. In the two cases in which Professor Watts is interested, we urgently recommend that both of them be published and that the SOCIETY waive its right to prohibit subsequent publication elsewhere. Further, we also believe that the SOCIETY should not in this case adhere to the other rule that it will not publish anything which will be published elsewhere in English because of the fact that this material is of direct interest to practically all of the members of the White Wares Division, and many of them will not get it otherwise because Engineering Experiment Station Bulletins are not always available. It must be remembered that one-third to one-half of our technical programs are supplied by the universities and government bureaus and it is our feeling that unless we treat the publication of these articles rather liberally we are going to discourage their taking part in the AMERICAN CERAMIC SOCIETY programs.

Possibly the best way to handle these situations is to take care of each of them individually, as Mr. Purdy suggested, but if it is done in this way it should be taken care of promptly and with the least amount of embarrassment and delay to the authors. We suggest for this purpose that we return to the method formerly employed in handling these cases. This is described in Mr. Purdy's letter of November 27 to Mr. Kraner. This procedure worked effectively and satisfactorily in the past and we do not believe that it should be disturbed at this time.

E. H. FRITZ, *Chairman*
H. M. KRANER, *Secretary*

White Wares Division

Corning Glass Works
Corning, New York
December 14, 1931

Messrs. E. H. Fritz and H. M. Kraner
Derry, Pa.

Gentlemen:

With reference to your letter of December 10 on papers by P. F. Collins and A. S. Watts, the paper by Collins will be published in the January issue of the *Journal of the American Ceramic Society* as advised by letter of November 27 from the General Secretary of the SOCIETY. The Publications Committee decided that this paper, inasmuch as it was in the hands of the General Secretary at the time of our resolution, was not barred from publication by our resolution.

We feel quite sure that if any of the members of the AMERICAN CERAMIC SOCIETY were aware of the exact situation in attempting to publish papers simultaneously with publications elsewhere that they would be in strong adherence to our policy of abolishing this practice. It did not turn out to be practical inasmuch as the AMERICAN CERAMIC SOCIETY had to have considerable advance notice of publication. In some cases it takes a long time to prepare a paper for publication and we cannot on two weeks' notice of a publication date elsewhere prepare a paper and give it priority over everything else in order that it be published simultaneously.

There is no ruling in the SOCIETY which prevents republication of a paper in the American language or any other language provided permission is secured to republish a paper previously published in the *Journal* and to give the *Journal* recognition. That is strictly the business of the other journals and if they think it advisable to go to additional expense of republication, I see no reason why we should object to it.

This ruling of the Publications Committee not to republish printed matter is not one which is unique with the AMERICAN CERAMIC SOCIETY, but is strictly adhered to by all other major technical and scientific societies of this country.

To be specific, the paper by A. S. Watts to which you refer falls under the ruling above mentioned and could not be published in the *Journal* if it were to be published elsewhere simultaneously or previously. If, however, after publication in the *Journal*, some other journal or bureau desires to republish this paper, permission unquestionably could be obtained for its republication.

So far as presentations of such papers at Meetings, the Publications Committee has waived all rights to such papers that are to be published elsewhere, for the program is left entirely in the hands of the separate Divisional Program Committees. I trust this letter has given you a satisfactory explanation both as to the papers to which you refer and as to the ruling of the Publications Committee to which you object.

Yours very truly,
(Signed) J. T. LITTLETON
Chairman, Publications Committee

NEW MEMBERS RECEIVED IN NOVEMBER

PERSONAL

Harold William Greider, Director of Research, Philip Carey Mfg. Co., Lockland, Ohio.
F. Y. Lee, National Tile Co., 112 Szechuen Rd., Shanghai, China.
Charles N. Witherow, Research Engineer, E. J. Lavino and Co., Berwinsdale, Clearfield County, Pa.

STUDENT

Elwin Henry Atwood, North Carolina State College, Raleigh, N. C.
Milton H. Berns, University of Alabama, University, Ala.
Clarence L. Evans, Ohio State University, Columbus, Ohio.
Norman L. Field, University of Washington, Seattle, Wash.
Vaughn K. Michael, University of Illinois, Urbana, Ill.
Ralph Graham Walsh, University of Saskatchewan, Saskatoon, Canada.
Roy Francis Wirth, University of Illinois, Urbana, Ill.

Membership Workers' Record

STUDENT		PERSONAL	
A. I. Andrews	1	W. J. Powell	1
J. L. Carruthers	1	Office	2
A. F. Greaves-Walker	1		
R. K. Hursh	1	Total	3
T. N. McVay	1		
Hewitt Wilson	1	Grand Total	10
W. G. Worcester	1		
Total	7		

ROSTER CHANGES IN NOVEMBER

CORPORATION*

Crescent China Co., C. F. Baker (voter), Alliance, Ohio. Name changed to Leigh Potters, Inc.
Straitsville Impervious Brick Co., John D. Martin (voter), New Straitsville, Ohio. Name changed to Moulding-Brownell Corp.

PERSONAL*

Brown, H. T., 216 S. Bloomington St., Streator, Ill. (65 Hampton St., Bridgeton, N. J.)
Callahan, H. D., Northwestern Terra Cotta Co., 4417 Oleatha Ave., St. Louis, Mo. (2525 Clybourn Ave., Chicago, Ill.)
Cook, Herman L., Roosevelt Park, Muskegon, Mich. (11 Maple Drive, Southern Hills, Dayton, Ohio.)
Greene, Kenneth F., 173 O'Neil St., Kingston, N. Y. (Gordon Art Tile Co., Bordentown, N. J.)
Irvine, George C., 2211 Wyandotte Ave., Lakewood, Cleveland, Ohio. (732 7th St., Niagara Falls, N. Y.)
Lipman, Reuel, 624 Foss Ave., Drexel Hill, Pa. (Johns-Manville Co., Manville, N. J.)
Schurecht, H. G., 85 Union St., Rahway, N. J. (Bureau of Standards, Washington, D. C.)
Soler, Gilbert, Timken Steel and Tube Co., Canton, Ohio. (52 W. Northwood Ave., Columbus, Ohio.)
Stevens, Frank J., Dallas Manor Apartments, Dallas Heights, Chattanooga, Tenn. (414 Prospect St., Nutley, N. J.)
Thornton, Paul E., 428 Argyle St., Waterloo, Iowa. (47 Hubbard Ave., Mt. Clevens, Mich.)
Weightman, Hugh E., 224 N. 2nd St., De Kalb, Ill. (4203 Keystone Ave., Chicago, Ill.)

* Addresses within the parentheses represent the old addresses.

These roster changes which are published each month may be checked against the complete Membership Roster which appeared in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

ART DIVISION EXHIBITION

Chicago, Ill.
December 19, 1931

To Members of the Art, Terra Cotta, and White Wares Divisions:

You are urgently asked to contribute to the Art Division Exhibition to be held in Washington during February, 1932. Because of the successful Sloane Exhibition, the tendency may be to let this chance pass. From the point of view of development of ceramic interest, publicity, and marketing, there is no better opportunity for progress than in this annual Exhibition held during the SOCIETY's Meeting. Pottery shown at Sloane's will be accepted. Please send your choicest pieces whether or not you exhibited there.

We are fortunate in securing the Galleries of the former Art Center, at 1105 Connecticut Avenue, which are now under the direction of Theodore Morgan for the Home Construction Division of Sears Roebuck Company. The Exhibition will be arranged by the Gallery management.

Conditions of the Exhibition are as follows:

(1) Work must be delivered unpacked at the Galleries by February 1. Rates were secured from packers in Washington and it was found that the rates of the Security Storage Company, 1140 15th Street, are favorable. They will unpack, deliver to Gallery, collect from Gallery, repack, and reship Exhibition work. If the majority of exhibitors use this company, the regular rate may be lessened.

(2) Insurance will be carried by the Division while work is in the Security Storage Company's care and at the Gallery. In former years the AMERICAN CERAMIC SOCIETY has paid this insurance.

(3) The entrance fee will be $1.00 and should be sent to Miss Marion L. Fosdick, Alfred, New York, by January 15. The entrance fee was reduced for this Exhibition because the exhibitor's expense will be slightly greater than during previous Exhibitions when the AMERICAN CERAMIC SOCIETY paid packing expenses.

(4) Entrance blanks and labels may be secured from Miss Marion L. Fosdick. Labels must be made out corresponding to entrance blanks, and attached to pottery. Coöperation in this, as well as prompt shipment will do much to help the Committee in an estimate of the size of the Exhibition, cost of insurance, and fabrics needed for backgrounds.

Yours very truly,
MYRTLE M. FRENCH
Chairman, Committee on Exhibition,
Art Division, AMERICAN CERAMIC SOCIETY

COMMITTEE ON EXHIBITION
Myrtle M. French
Marion L. Fosdick
William E. Ross

CERAMIC SCHOOL NOTES

Penn State Ceramic Society

In order to arouse deeper interest in the meetings, the Penn State Ceramic Society, which meets the first Tuesday of each month, has added a new feature to its meetings in the form of short talks on ceramic subjects by members of the Society. These talks are to be simply but effectively presented so that the underclassmen as well as the upperclassmen may derive full benefit from them.

Dinner meetings will intersperse the regular lecture meetings, and will be addressed by men in the ceramic industry.

An illustrated lecture entitled "High Temperature Insulation" was given on Nov. 10, 1931, for the benefit of the ceramic students through the courtesy of the Johns-Manville Corporation. In addition to the group of films shown, J. B. Shaw and G. J. Bair further discussed insulation materials and their importance in the industry today.

Ohio State University

The Ohio State University Student Branch of the AMERICAN CERAMIC SOCIETY held its third monthly meeting on Tuesday, December 8, 1931, at Lord Hall. Dr. S. R. Scholes of the Federal Glass Co., Columbus, Ohio, who was the speaker for the evening, gave a talk on "The Ceramic Graduate in Industry," and answered questions pertaining to the glass industry. A business meeting was held following the talk, in which reports from the Engineers Council and the Advisory Board were discussed. Refreshments were served after the meeting.

NOTES AND NEWS

THE OHIO CERAMIC INDUSTRIES ASSOCIATION

Survey of Refractories Service Conditions in Ceramic Kilns

The Ohio Ceramic Industries Association has requested the Research Committee of the Refractories Division to formulate specifications on refractories for ceramic kilns. The information requested below is to be used for that purpose:

(1) Type of Kiln. Also describe the kind of ware manufactured and state whether or not salt glazing is used.
(2) Kind of Fuel and Method of Firing. If coal is used, describe the quality and source.
(3) Maximum Temperature and Duration of Fire. Give maximum cone which is brought down.
(4) Kind of Refractories Used. (Grade by handmade, steam press, or dry press and give P.C.E.) (*a*) Fire boxes, (*b*) crown and side walls, (*c*) floor brick, (*d*) bag walls.
(5) Approximate Length of Service before Major Repairs Are Required. (*a*) Fire boxes, (*b*) crown and side walls, (*c*) floor brick, (*d*) bag walls.
(6) Size of Floor Brick and Design of Fire Boxes. State whether 9-inch brick or special circle blocks are used in arches.
(7) Give results of experience or suggestions which will be valuable in formulating suitable specifications.

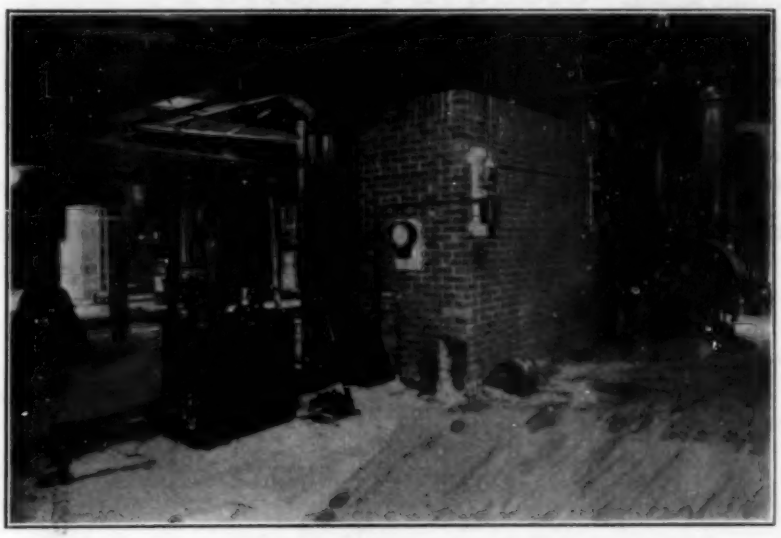
CALENDAR OF MEETINGS

Organization	Date	Place
AMERICAN CERAMIC SOCIETY	February 7–13	Washington, D. C.
American Chemical Society	March 14–18	New Orleans, La.
American Engineering Council	January 14–16	Washington, D. C.
American Foundrymen's Assn.	May 2–6	Philadelphia, Pa.
American Gas Assn.	October 10–16	Atlantic City, N. J.
American Society for Testing Materials	June 20–24	Atlantic City, N. J.
Common Brick Mfrs. of America	February 1–6	Louisville, Ky.
Electrochemical Society	April 21–23	Baltimore, Md.
National Assn. of Manufacturers of Pressed and Blown Glassware	March 8	Pittsburgh, Pa.
National Brick Manufacturers Research Foundation	February 7–13	Washington, D. C.
National Paving Brick Assn.	February 10–12	Chicago, Ill.
Sand-Lime Brick Assn.	February 3–4	Washington, D. C.
Scientific Apparatus Makers of America	May	Wernersville, Pa.
Structural Clay Tile Assn.	February 17–19	Chicago, Ill.
Tile & Mantel Contractors' Assn. of America, Inc.	February 9–12	Rochester, N. Y.

REPLACEMENTS FOR PROFIT

PowermakeR
Hydraulic Car Propeller

PRODUCTION DEPENDS on the CAR PROPELLER



This plant, like many others, has found it profitable to replace an obsolete make of car propeller with a modern PowermakeR Hydraulic Car Propeller. Continuous movement of the kiln car train through the Tunnel Kiln is assured. Costly shut-downs are eliminated and maintenance expense is cut to the minimum.

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CERAMIC EQUIPMENT
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HYDRAULIC CAR PROPELLERS

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COOK ENGINES
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B

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Hommel, O., Co.
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Ball Mills (Laboratory Type)
Hommel, O., Co.

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Harshaw Chemical Co.
Hommel, O., Co.

Barytes
Harshaw Chemical Co.
Hommel, O., Co.

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Carborundum Co. (*"Carbofrax Aloxite"*)
Norton Co. ("Alundum-Crystolon")

Bitstone
Harshaw Chemical Co.
Potters Supply Co.

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Carborundum Co.
Norton Co.

Boats, Combustion
Norton Co.

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Borax Glass
Harshaw Chemical Co.
Pacific Coast Borax Co.

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Hommel, O., Co.
Pacific Coast Borax Co.

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American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
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Carborundum Co. (*"Carbofrax Aloxite"*)
Norton Co. (*"Alundum Crystolon"*)

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Swindell-Dressler Corp.

C

Carbofrax (Refractory Products)
Carborundum Co.

Carbolon (Refractory Products)
The Exolon Co.

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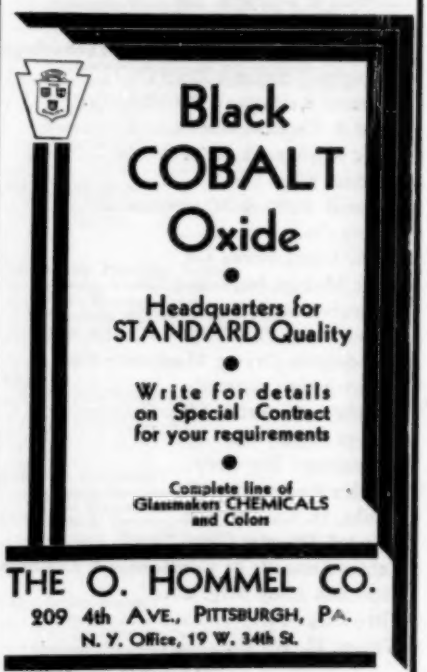

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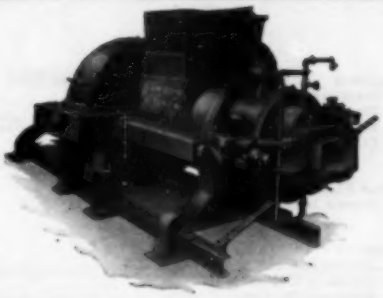

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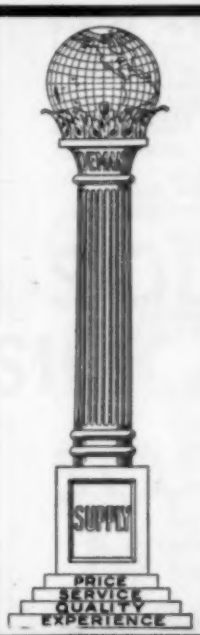

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